

# BIOLOGY of CRUSTACEANS

Kod: (172453)

2+1+0 (L+E+S)

ECTS 5



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# -Family Astacidae (& Cambaridae & Parastacidae)

- biology
- ecology
- phylogeny
- phylogeography
- diseases
- epibionts





## Family Astacidea (order Decapoda)

- Native European species
- biggest freshwater invertebrates
- key species
- endangered



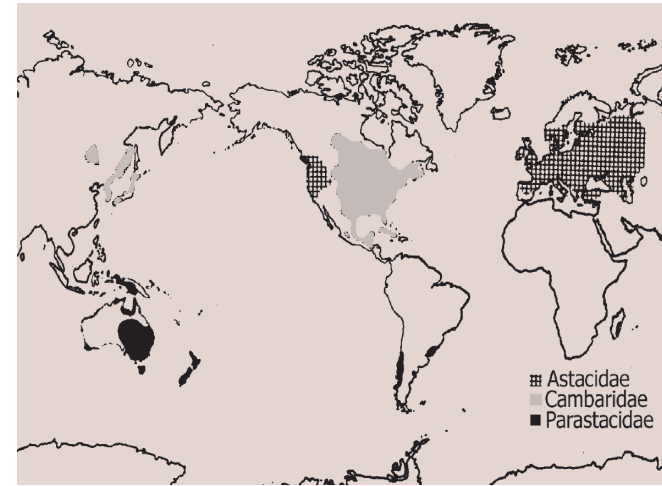
*Astacus astacus*



*Pontastacus leptodactylus*



*Austropotamobius pallipes*



(Hobbs, 1988)



*Austropotamobius torrentium*



# Course schedule

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## BIOLOGY of CRUSTACEANS

LECTURES

EXERCICES







# CALENDAR

## 2024./2025.



### KALENDAR AKTIVNOSTI ZA PRIRODOSLOVNE ODSJEKE

rujan 2024.						
P	U	S	Č	P	S	N
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
I.	30					

listopad 2024.						
P	U	S	Č	P	S	N
I.	1	2	3	4	5	6
II.	7	8	9	10	11	12
III.	14	15	16	17	18	19
IV.	21	22	23	24	25	26
V.	28	29	30	31		

studenj 2024.						
P	U	S	Č	P	S	N
V.					1	2
VI.	4	5	6	7	8	9
VII.	11	12	13	14	15	16
VIII.	18	19	20	21	22	23
IX.	25	26	27	28	29	30

prosinac 2024.						
P	U	S	Č	P	S	N
						1
X.	2	3	4	5	6	7
XI.	9	10	11	12	13	14
XII.	16	17	18	19	20	21
XIII.	23	24	25	26	27	28
	30	31				

siječanj 2025.						
P	U	S	Č	P	S	N
		1	2	3	4	5
XIII.	6	7	8	9	10	11
XIV.	13	14	15	16	17	18
XV.	20	21	22	23	24	25
XVI.	27	28	29	30	31	

veljača 2025.						
P	U	S	Č	P	S	N
					1	2
1.	3	4	5	6	7	8
2.	10	11	12	13	14	15
3.	17	18	19	20	21	22
4.	24	25	26	27	28	

ožujak 2025.						
P	U	S	Č	P	S	N
						1
I.	3	4	5	6	7	8
II.	10	11	12	13	14	15
III.	17	18	19	20	21	22
IV.	24	25	26	27	28	29
V.	31					

travanj 2025.						
P	U	S	Č	P	S	N
V.	1	2	3	4	5	6
VI.	7	8	9	10	11	12
VII.	14	15	16	17	18	19
VIII.	21	22	23	24	25	26
IX.	28	29	30			

svibanj 2025.						
P	U	S	Č	P	S	N
IX.			1	2	3	4
X.	5	6	7	8	9	10
XI.	12	13	14	15	16	17
XII.	19	20	21	22	23	24
XIII.	26	27	28	29	30	31

lipanj 2025.						
P	U	S	Č	P	S	N
						1
XIV.	2	3	4	5	6	7
XV.	9	10	11	12	13	14
XVI.	16	17	18	19	20	21
1.	23	24	25	26	27	28
2.	30					

srpanj 2025.						
P	U	S	Č	P	S	N
2.	1	2	3	4	5	6
3.	7	8	9	10	11	12
4.	14	15	16	17	18	19
	21	22	23	24	25	26
	28	29	30	31		

kolovoz 2025.						
P	U	S	Č	P	S	N
						1
					2	3
	4	5	6	7	8	9
	11	12	13	14	15	16
	18	19	20	21	22	23
1.	25	26	27	28	29	30
	31					

rujan 2025.						
P	U	S	Č	P	S	N
2.	1	2	3	4	5	6
3.	8	9	10	11	12	13
4.	15	16	17	18	19	20
	22	23	24	25	26	27
	28					

- Državni blagdani
- Dan i noć PMF-a, nastavni dan
- Nastava
- WISE nastavni dan
- Ispiti
- Dan fakulteta, ima nastave

**LECTURES**  
**Friday 14h-16h in RAČUNALNI PRAKTIKUM**

**EXERCISES**  
**Field and lab work (RAČUNALNI PRAKTIKUM)**

**EXAM = SEMINAR**



# GRADING

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## LECTURES

Participation : minimally at 7 lectures

## EXERCISES

mandatory (one absence is ok)  
field work is a part of excercises

# COURSE CONTENT

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1. Introduction to crustacean biology (historical overview, diversity, success, similarities of, and the differences between crustaceans and other arthropods).
2. Systematic and evolution of crustaceans
3. Crustacean phylogeny
4. Comparative anatomy and morphology of class Remipedia
5. Comparative anatomy and morphology of class Cephalocarida
6. Comparative anatomy and morphology of class Branchiopoda
7. Comparative anatomy and morphology of class Maxillopoda
8. Comparative anatomy and morphology of class Malacostraca
9. Biology and ecology of gammarid species in Croatia
10. Reproduction, life cycles and crustacean behaviour
11. Microbiology, epibionts, diseases and crustacean aquaculture
12. Invasive crustaceans in Europe
13. Crustacean conservation, management and legislation
14. Ecological characteristics of freshwater crayfish in Croatia
15. Vulnerability and protection of the family Astacidae in Europe



no.	date	topic	note
1.	11.10.2024.	Into lecture	Prof. dr. sc. Sanja Gottstein & Prof. dr. sc. Ivana Maguire
<b>x.10.2024.</b>		fieldwork 1 – Medvednica / Podsused + labwork	Prof. dr. sc. Sanja Gottstein & Prof. dr. sc. Ivana Maguire
<b>x. 10.2024.</b>		fieldwork 2 – Maksimir + labwork	Prof. dr. sc. Sanja Gottstein & Prof. dr. sc. Ivana Maguire
2.	18.10.2024.	Crustacean systematics, taxonomy and phylogeny	Prof. dr. sc. Ivana Maguire & Prof. dr. sc. Sanja Gottstein
3.	25.10.2024.	<b>classes: Remipedia &amp; Cephalocarida</b>	Prof. dr. sc. Sanja Gottstein
4.	8.11.2024.	<b>class Branchiopoda</b>	Prof. dr. sc. Ivana Maguire
5.	15.11.2024.	<b>Partial exam II</b>	
6.	22.11.2024.	<b>class Maxillopoda1 – MYSTACOCARIDA, COPEPODA, OSTRACODA</b>	Prof. dr. sc. Sanja Gottstein
7.	6.12.2024.	<b>class Maxillopoda2 – THECOSTRACA, TANTULOCARIDA, BRANCHIURA, PENTASTOMIDA</b>	Prof. dr. sc. Ivana Maguire
8.	13.12.2024.	<b>class Malacostraca1 – LEPTOSTRACA, HOPLOCARIDA, SYNCARIDA, EUCARIDA</b>	Prof. dr. sc. Ivana Maguire
9.	20.12.2024.	<b>class Malacostraca 2 - supraclass Peracarida</b>	Prof. dr. sc. Sanja Gottstein
10.	10.1.2025.	Biology and ecology of gammarids in Croatia	Prof. dr. sc. Sanja Gottstein
11.	17.1.2025.	Microbiology, epibionts, diseases, invasive crustaceans, aquaculture	Prof. dr. sc. Ivana Maguire
12.	24.1.2025.	Reproduction, life cycles and behaviour of crustaceans conservation, management, law	Prof. dr. sc. Sanja Gottstein
13.	31.1.2025.	<b>Partial exam II</b>	

# EXERCIES include:

**field work** (different sampling methods, fixation, documentation and determination of the crustaceans)

**lab work** (analyses of samples and data from the field, crustacean behaviour).

- **FIELD WORK**

	LOCATIONS	TIME
1.	Field trip to the Medvednica Mt. (Dolje Stream, subthermal source (Sutinska vrela) and aquifer of the Sava valley (Podsused)) + krenal (Northon pump)	<b>19.10. 2024.</b>
2.	Maksimir lakes' crustaceans– plankton & LiNi traps	<b>26.10. 2024.</b>



- LAB work

	<b>What?</b>	<b>When?</b>
1.	Crayfish determination	? .10.2024.
2.	Determination of crustaceans from Sutinska vrela freatika	? .10.2024.
3.	Analysis of crustaceans' density in the plankton samples	? .10.2024.

# LEARNING OUTCOMES

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1. Explaining the characteristics contributing to the diversity of crustaceans and their success to inhabit various ecosystems.
2. Defining the anatomical similarities of, and the differences between crustaceans and other arthropods.
3. Identifying and explaining the key morphological differences of each crustacean group.
4. Comparing external and internal crustacean anatomy.
5. Implementing various laboratory and field methods that are related to collecting, preparing, documenting and determining different crustacean.
6. Explaining the survival, reproduction and life strategy of different crustacean groups.
7. Describing the applications of crustacean ecology to conservation, wildlife management and legislation.

# LITERATURE



- Martin, J. W., Davis, G. E. 2001. An Update Classification of the Recent Crustacea. Natural History Museum of Los Angeles County, Science Series 39: 1-124.
- Saxena, A. 2005. Text book of Crustacea. Discovery Publishing House. New Delhi, vii+555 str.
- Schram, F.R. & Koenemann, S. 2004. Are crustaceans monophyletic? In: J. Cracraft & M.J. Donoghue (eds.), Assembling the Tree of Life: str. 319-329. Oxford University Press: Oxford, New York.





# ADDITIONAL LITERATURE



- Gottstein Matočec, S. (ur.), Ozimec, R., Jalžić, B., Kerovec, M., Bakran-Petricioli, T. 2002. Raznolikost i ugroženost podzemne faune Hrvatske. Ministarstvo zaštite okoliša i prostornog uređenja, Zagreb, str. 1-82.
- Gottstein Matočec, S. (ur.), Bakran-Petricioli, T., Bedek, J., Bukovec, D., Buzjak, S., Franičević, M., Jalžić, B., Kerovec, M., Kletečki, E., Kralj, J., Kružić, P., Kučinić, M., Kuhta, M., Matočec, N., Ozimec, R., Rađa, T., Štamol, V., Ternjej, I. & N. Tvrković 2002. An overview of the cave and interstitial biota of Croatia. *Natura Croatica* 11 (Suppl. 1): 1-112.
- Gottstein, S. 2010. Priručnik za određivanje podzemnih staništa u Hrvatskoj prema direktivi o staništima EU. Državni zavod za zaštitu prirode, Zagreb, str. 1-99.
- Maguire I, Gottstein-Matočec S. (2004) The distribution pattern of freshwater crayfish in Croatia. *Crustaceana* 77, 1: 25-47.
- Maguire I. (2010) Slatkovodni rakovi – Priručnik za inventarizaciju i praćenje stanja. Državni zavod za zaštitu prirode, Zagreb. 40 p.
- Souty-Grosset, C., Holdich, D. M., Noël, P., Reynolds, J. D. & P. Haffner (2005). Atlas of Crayfish in Europe. Publications Scientifiques Museum National d'Histoire Naturelle, Paris, France.
- Watling, L., Thiel, M. 2013. Functional Morphology and Diversity. The Natural History of the Crustacea No. 1. Oxford University Press, Oxford, New York.
- Crandall, K., De Grave, S. 2017. An updated classification of the freshwater crayfishes (Decapoda: Astacidea) of the world, with a complete species list. *Journal of Crustacean Biology* (2017) 1–39.

# SOCIETIES

## 1. The Crustacean Society - USA

**Mission** – Advancing the study of all aspects of crustacean biology through info sharing

<http://www.thecrustaceansociety.org/>



CONGRESSO BRASILEIRO SOBRE CRUSTÁCEOS (CBC)  
THE CRUSTACEAN SOCIETY (TCS) - SUMMER MEETING



**XI CBC**  
**TCS Summer Meeting**  
June 05-08<sup>th</sup>, 2022  
Santos - Brazil

COUNTDOWN

590 Days	20 Hours
38 Minutes	55 Seconds

**INSCRIÇÕES ABERTAS**  
OPEN FOR REGISTRATION

THEME

Tradition and Innovation:  
Integrative Approaches to Crustacean Studies

## 2. Other societies

- Sociedade Brasileira de Carcinologia



- World Association of Copepodologists

- British Marine Life Study Society: Crustacea

- International Association for Astacology



- International research group on Ostracoda

- The Carcinological Society of Japan



日本甲殻類学会





# “newspapers” & journals....

## “newspapers”

- *Amphipod Newsletter*
- *Anostracan News*
- *Coral Reef Newsletter*
- *Crayfish News*
- *Cypris* (Ostracoda)
- *Cumacean Newsletter*
- *Ecdysiast* (Službeni glasnik The Crustacean Society)
- *Isopod Newsletter*
- *The Lobster Newsletter*
- *Monoculus* (Copepoda)
- *Plankton Newsletter*
- *SCAMIT Newsletter* (Southern California Association of Marine Invertebrate Taxonomists)
- *Shrimp News International*
- *The Stomatopod Newsletter*
- *The Tanaidacea Newsletter*
- *Zoea*

## journals



...to find and download - link

## publication

Martin & Davis (2001) **Classification of Crustacea**

De Grave, S., N. D. Pentcheff , S. T. Ahyong, T.-Y. Chan, K. A. Crandall, P. C. Dworschak, D. L. Felder, R. M. Feldmann, C. H. J. M. Fransen, L. Y. D. Goulding, R. Lemaitre, M. E. Y. Low, J. W. Martin, P. K. L. Ng, C. E. Schweitzer, S. H. Tan, D. Tshudy, and R. Wetzer. **2009. A classification of living and fossil genera of decapod crustaceans.**

## LINK

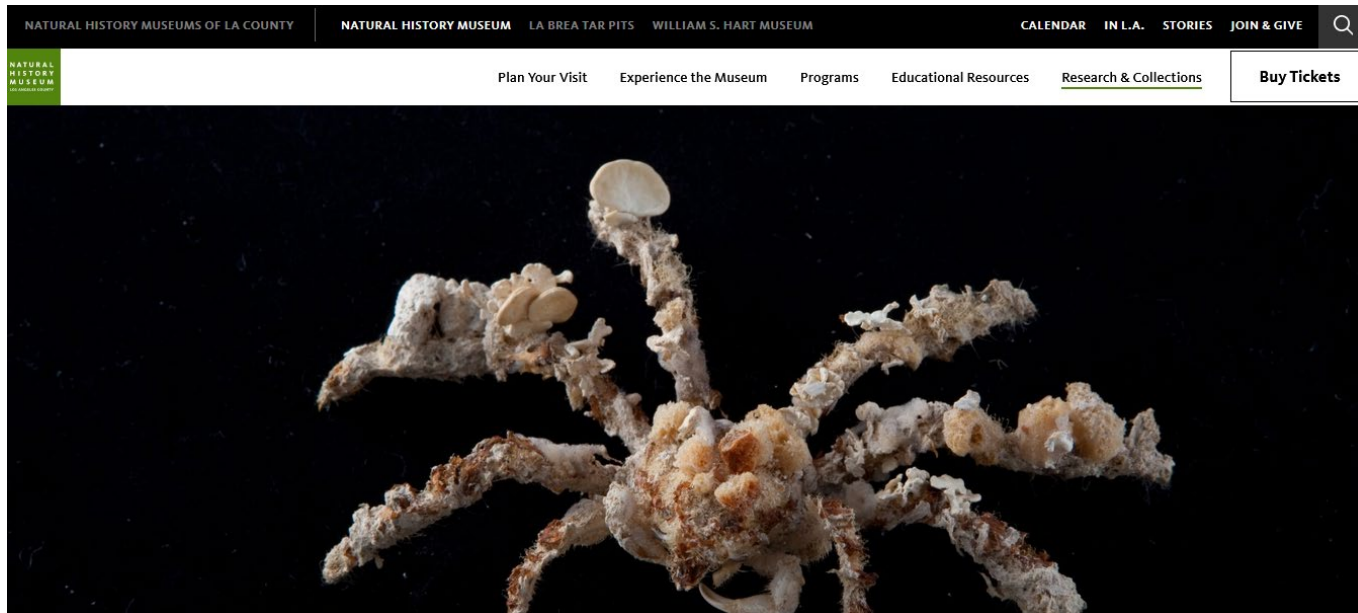
<http://www.thecrustaceansociety.org/>

# Collections – museums and private

- Natural history museum Los Angeles, USA

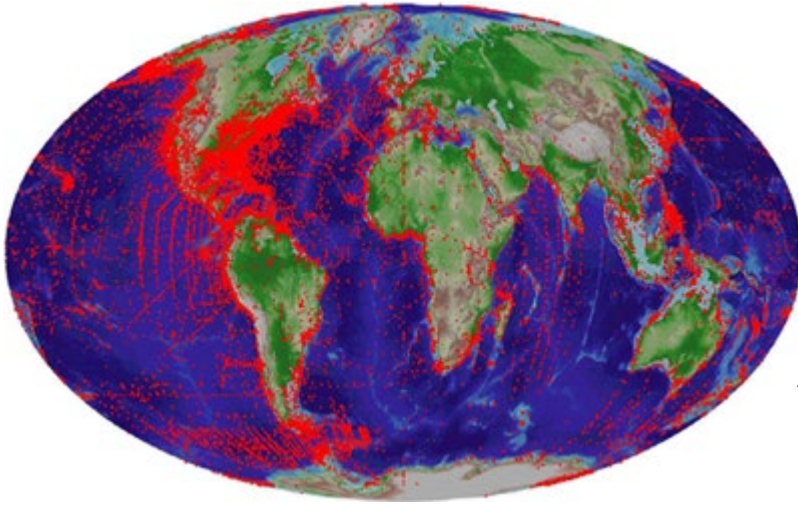


- 4th (size-wise) in the world
- 140 000 “pickled” jars (estimation - 5 mil. samples)
- east Pacific, Indian and Antarctic oceans and Caribbean sea
- marine, freshwater and terrestiral crustaceans



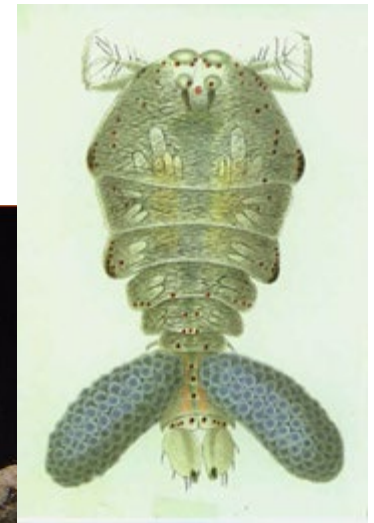


• Smithsonian National Museum of Natural history-Washington, USA



Global diversity of the National Invertebrate Collections (red dots indicate localities of IZ collections)

A drawing by Giesbrecht (1892) of the Copepoda, *Sapphirina auronitens* Claus, 1863



NATIONAL MUSEUM of NATURAL HISTORY

DEPARTMENT OF

# Invertebrate Zoology

1,934,364 crustacea in collection



# • The Queensland Museum (Australia)

- 48 122 crustaceans
- due to climate and habitat this part of Australia is the most diverse (both marine and freshwater crustaceans)



## Crustaceans collections

Queensland has the highest diversity of marine and terrestrial crustaceans in Australia. This is due to the rich diversity of habitats in tropical and subtropical climates. The collection contains:

- about 27,000 registered specimen lots, about 9,000 unregistered;
- over 1400 type specimens;
- strengths in decapods (crabs, shrimps, lobsters and their relatives);
- Indo-West Pacific mangrove and shore crabs; one of the most comprehensive in the world, and includes almost all Australian species;
- about 75% of the collection is databased.



*Trapezia septata*



- **Iziko South African Museum (JAR)**  
- **Crustacean Collection**

- the biggest crustacan collection in Africa
- 5101 samples from 274 crustacean families

#### Crustacean Collections

Iziko South African Museum houses the most important crustacean (crabs, lobsters, shrimps, barnacles) collection in South Africa. Significant past contributions were made by K.H. Barnard, J.R. Grindley and B.F. Kensley (Crustacea).



Land crab



## African Decapoda Crustacea collection - MUHNAC

Published by [National Museum of Natural History and Science, University of Lisbon](#)

The collection of African decapod crustaceans is part of the Crustacea collection of the Museu Nacional de História Natural e da Ciência, Universidade de Lisboa. It comprises 1114 accessions, which correspond to about 4528 specimens of decapod crustaceans belonging to 86 families.



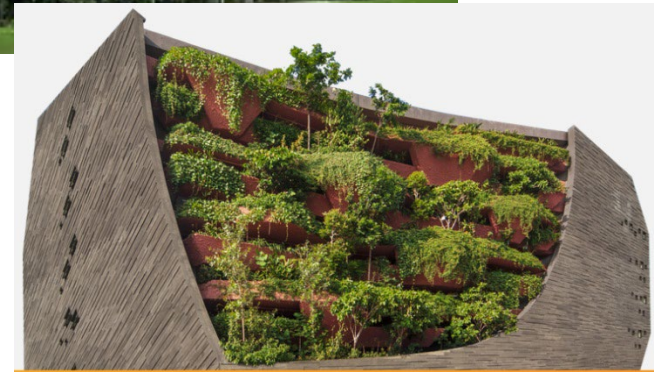


• **Raffles museum of biodiversity research, Singapur (Asia)**

- decapode crustacean collection (along with National Museum of Japan i the Zoological Survey of India )









- collection was made during '50-'70 (terrestrial, deep sea)

- cca 22000 specimens (1 200 species)



**Animalia**

+ Show description

<p><b>Acoelomorpha</b></p>  <p>Very small worms up to 1 cm long that do not have a gut cavity. Instead, they possess a syncytium (multinucleated cell-...</p>	<p><b>Annelida</b></p>  <p>Traditionally regarded as consisting only of segmented worms, such as bristleworms, earthworms, and leeches. Phylogenet...</p>	<p><b>Arthropoda</b></p>  <p>...a ... their jointed ... eton. The ... in inhi...</p>
<p><b>Chordata</b></p>  <p>The phylum Chordata comprises animals characterised by having, at some time in their life cycle, a notochord, a hollow d...</p>	<p><b>Cnidaria</b></p>  <p>The phylum Cnidaria is a group of animals that are radially symmetrical with their mouths surrounded by tentacles that b...</p>	<p><b>Echinodermata</b></p>  <p>The phylum Echinodermata is a group of animals which are radially symmetrical based on a five-fold organisation of skele...</p>
<p><b>Mollusca</b></p>  <p>The phylum Mollusca is a group of animals with an unsegmented bilateral body. Many species have a calcareous shell, whic...</p>	<p><b>Porifera</b></p>  <p>Simple, multi-cellular animals without a mouth, stomach, eyes, heart or similarly complex organ systems. Instead, severa...</p>	

**Raffles Museum of Biodiversity Research Open House 2010**  
video on vimeo

- **The Zoological Museum, University of Copenhagen (Denmark)**

- up till now c. 12 000 species from the collection were described (=70% of samples, work on the collection is continuous)

- orders Isopoda & Amphipoda



1649



Ingolf Expedition (North Atlantic, deep-sea; 1895-96), the Dana Expedition (world oceans, pelagic; 1928-30), the Atlantide Expedition (West Africa, shelf; 1945-46), the Galathea Expedition (world oceans, deep sea; 1952-53),

- **Zoological Museum Amsterdam (University of Amsterdam)(NL)**

- crustacean collection includes cca. 90 000 samples in EtOH, 650 dry samples & 4 500 microscopis slides

- 2 250 crustacean species (Decapoda, Isopoda, Amphipoda, Copepoda i Thermosbaenacea)



- **National Museum of Natural History u Leidenu (NL)**

The launch of Naturalis Biodiversity Center and its over **37 million objects** – has created a world-class, natural history collection ranking **fifth in the world**, both in size and content.





• Oxford University Museum of Natural History – Darwin’s crustacean collection from “Beagle”



*Mithrax* sp.

From Darwin’s diary, march 1834., Tierra del fuego,  
“Crust. Bracy. & Macro. Hab: east end of Beagle Channel”



A male fiddler crab (*Uca vocans*) collected by Charles Darwin.



the dedication which is  
so honourable to me.

You show wonderful spirit  
in going again to the Amazon  
& I sincerely hope that you  
may be in every way successful.

My dear Sir

yours very faithfully

Charles Darwin

Bonhams auction house in New York-  
auction on Oct. 22, 2014  
(pre-sale estimate of \$20,000 to \$30,000)

- June 19, 1876 letter by Darwin to a  
colleague, on the sex life of barnacles

•The Museum of Natural History in Vienna (Austria)

- Crustacean collection from mid 18th century



Camil Heller

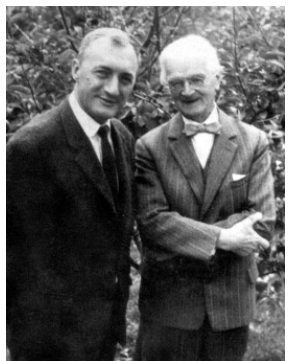
Fregata "Novara" (oko 1861.)



Research boat "Pola" - 1895



Georg von Frauenfeld



Otto Pest

- **Natural history museum in Rijeka**

- the crustacean collection, like the other collections of the Rijeka Natural History Museum, is based on the material of the Hungarian Royal Biological Station (around 200 inventory numbers)



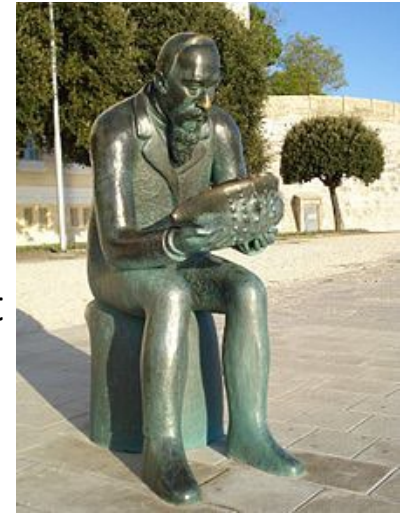
- **Natural history museum in Zagreb**

- the permanent exhibition dates from the middle of the 19th century (systematic exhibition + depot of teaching materials) and contains a collection of crustaceans



- **Zavičajni muzej / Homeland museum Obrovac**

- the permanent exhibition "On the trail of young Brusina through the Obrovac region" through photos, text, cave drawings and exhibition specimens of land snails and **freshwater crayfish** shows the scientific journey and research of the wider Obrovac area of the young scientist back in 1863.



- **Narodni muzej / National museum Zadar**

-the crustacean collection consists of dry and permanent wet preparations. For the most part, it is material collected in the last ten years. The oldest specimens, for which there is information about the place and date of discovery, date from 1969.





- **Natural history museum Dubrovnik**



Tel: +385 (0) 20 324 888  
Androvićeva 1, 20 000 Dubrovnik  
Stranica je u izradi / Web site is under construction



- **Natural history museum – Split**

- Crustacean collection (Crustacea) – new
- Crustacean collection (Crustacea) Girometta - Cvitanović

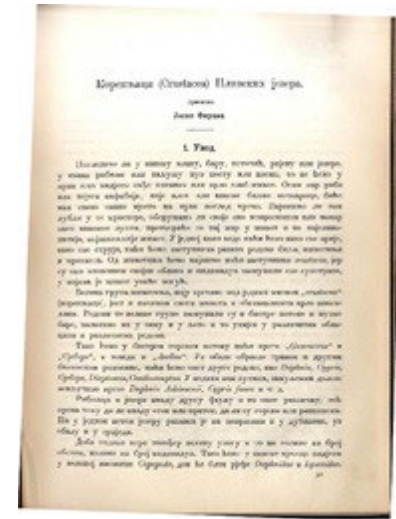


## Scientists

**Grube, 1861;** Ein ausflug nach Triest und dem Quarnero: 125. (Nicolaische Verlagsbuchhandlung, Berlin)

**Šoštarić, 1888;** Prilog poznavanju slatkovodnih korepnjaka Hrvatske GLASNIK ZEMALJSKOG MUZEJA, br.1897/03, str.399, 01/07/1897

**Car, 1901;** Prilog za faunu Crustacea. U: A. HEINZ (ed.), Glasnik Hrvatskog naravoslovnog društva, 84: 4-6.



**Brusina, 1995;** XVI. Prilog za faunu rakâ Dalmacije i Jadranskog mora. U: J. BALABANIĆ (ed.), Naravoslovne crtice sa sjeveroistočne obale Jadranskog mora: 360-391. (Dom i svijet, HAZU, Hrvatski prirodoslovni muzej, Zagreb).

**Entz, 1914;** Über die Flusskrebse Ungarns. Mathematische und Naturwissenschaftliche Berichte aus Ungarn, [1912] 30: 67 – 127, 4 pls.. (Leipzig).



**Karaman Stanko, 1929;**

Die Potamobiiden Jugoslaviens. Glasnik zemaljskog muzeja u Bosni i Hercegovini, XLI: 147-150.

**Karaman Mladen – 60s last century**

**Karaman Gordan – active**

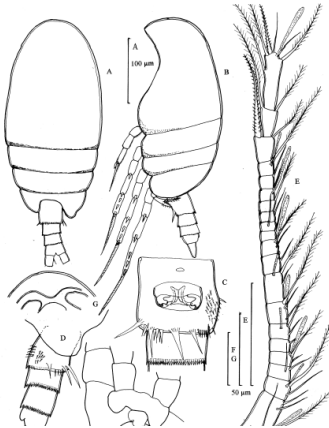


**Zdravko Štević** – Institut in Rovinj – Cirripedia, Brachyura



**Franjo Kršinić & Davor Lučić** – Institut for oceanography in Dubrovniku – plankton species (Copepoda)

JOURNAL OF PLANKTON RESEARCH | VOLUME 25 | NUMBER 8 | PAGES 939–948 | 2003



*Mesaiokeras hurei* n. sp. (Copepoda,  
Calanoida, Mesaiokeratidae) from  
the Adriatic Sea

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HRV-20001 DUBROVNIK CROATIA

**Marin Kirinčić** – Natural history museum in Rijeka – marine Decapoda



**Ivančica Ternjej** – PMF – freshwater Cladocera & Copepoda



**Andreja Lucić** – PMF – NICS Astacidae & Cambaridae

**Sandra Hudina** – PMF – NICS Astacidae & Cambaridae

**Paula Dragičević** – NICS Astacidae & Cambaridae



**BIUS-section for crustaceans**

**Goran Klobučar** – PMF – Astacidae

**Leona Lovrenčić** - Astacidae

**Mišel Jelić** – City museum in Varaždin – Astacidae



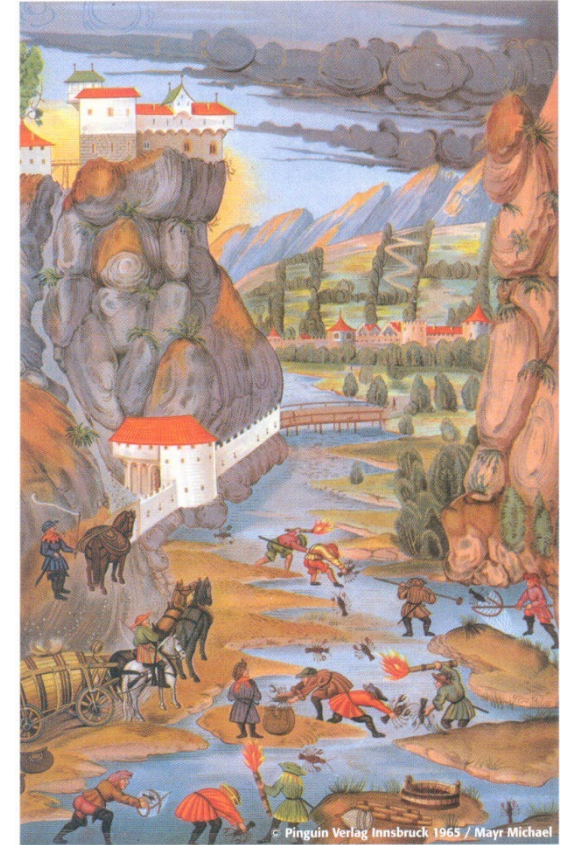
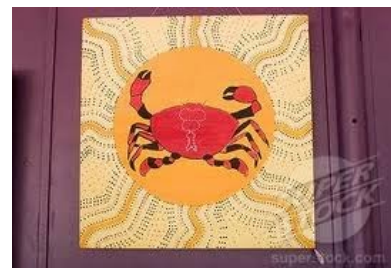
**Krešimir Žganec** – University of Zadar – family Gammaridae (order Amphipoda)



# Crustaceans and people

## • Art

- inspiration for more than 3 500 years
- focus on edible species
- first findings in Egyptian and Assyrian culture
- frequent in Roman culture (1. ct. BC – 4. ct. AD) – symbol of marine fauna
- Middle ages – rare – astrological symbols, allegories about water, mythology or religious symbols
- 15. to 17. ct. – Flemish paintings – way of life, present abundance and pleasant, leisure life
- later rare, but painters like them



Presents catch crayfish, book on fishing, emperor Maximilian I 1901. (adopted from CRAYNET atlas, 2006)



Annibale Carracci (Italian, Bologna 1560–1609 Rome)





Van Gogh



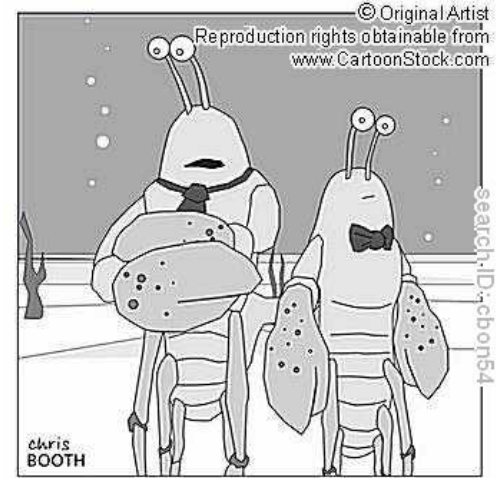
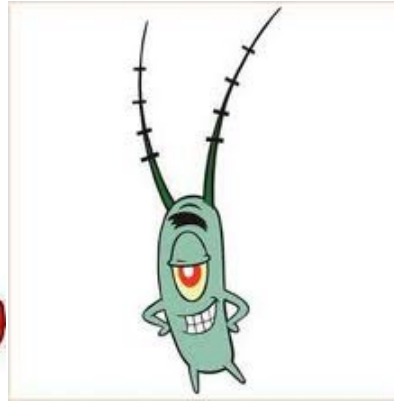
Karl Larsson (1899)



Picasso



- comics, cartoons, pc games, songs



No-one messed with The Crays

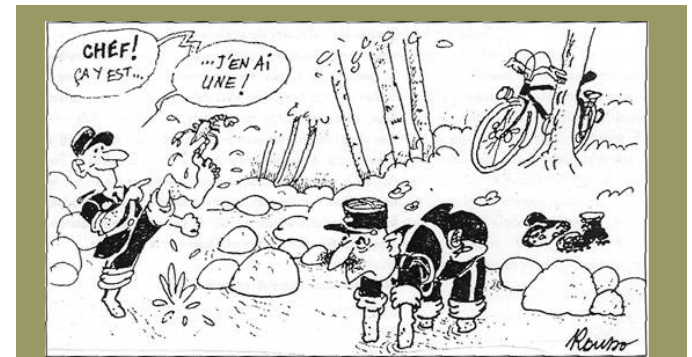
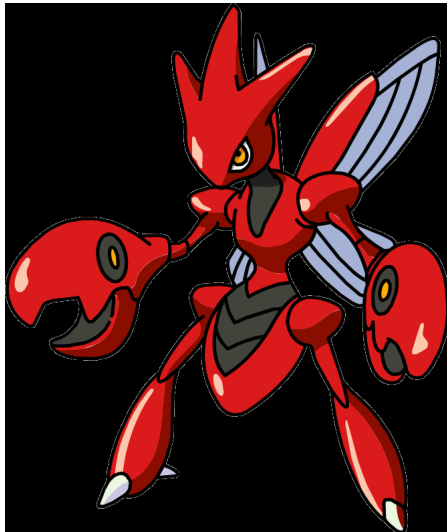


Fig. 20 French police operation for the eradication of the trouble-crayfish (non-indigenous crayfish species) (after Holdich & Whisson, 2004).



## Crayfish blues - I just want to moult



[http://photo.dastrand.com/2013/10/crayfish-blues-i-just-want-to-moult\\_13.html](http://photo.dastrand.com/2013/10/crayfish-blues-i-just-want-to-moult_13.html)

## Crayfish blues – I just wanna moult

*Lyrics by Stephanie Peay*

*Vocals & Harmonica by Lennart “Lelle” Edsman*

*Guitar by Thomas Abeel*

I woke up this morning  
It wasn't my fault  
My baby don't get it  
Yeah, I just wanna moult  
I just wanna moult  
I just wanna moult  
I needed to scratch it  
I knew I should catch it  
Perhaps I should patch it  
But I felt like a dolt  
Yeah, I felt like a dolt  
I'm too big for my britches  
It scratches and itches  
Bring on that ecdysis  
I'm falling to pieces  
Oh just let me moult  
Oh just let me moult  
Aaaaaaaaaaaaaaaaaaaaaahhh!!

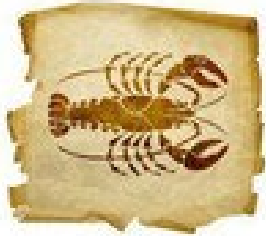
Yeah, moult for me baby!!

- In medicine

- against cancer during Middle
- source of omega fatty acids
- reducing weight (astaxanthin – strong **antioxidants**)



- horoskop signe



Cancer (21. 6. – 22. 7)

- money



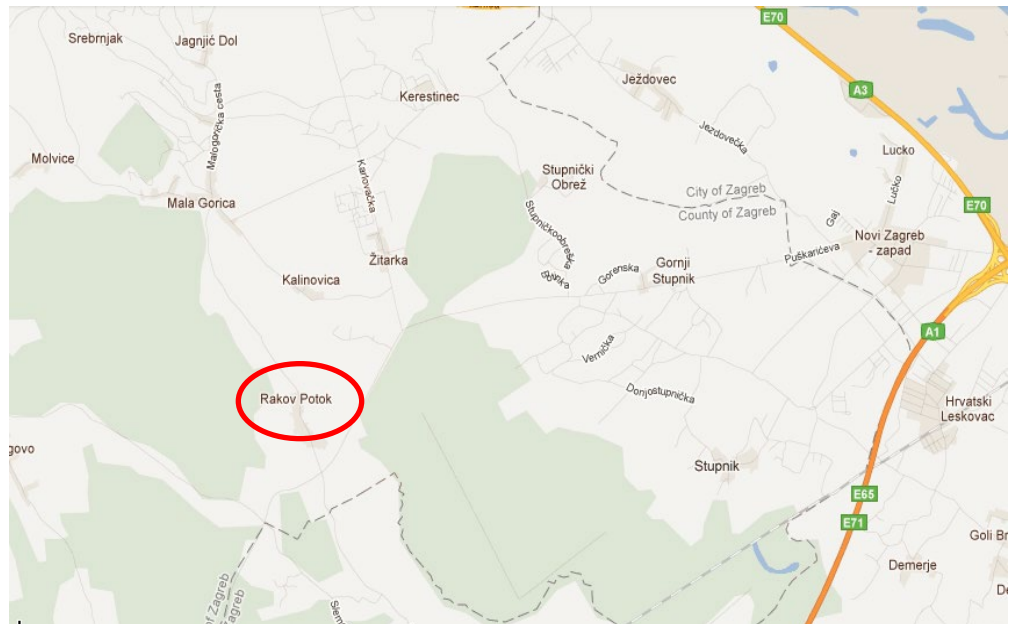
Sicily, 460 BC

- post stamps

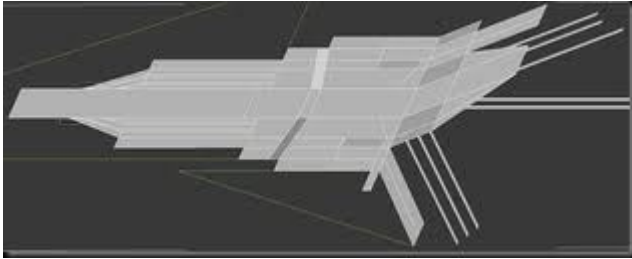




- names of rivers, places, counties



- in architecture



- Bus station in Queensland (Australia)



Market building Kuopio, Finland



Kerubin holding golden crayfish, baroque church Bavaria (foto: D. Holdich)

- **Designe**



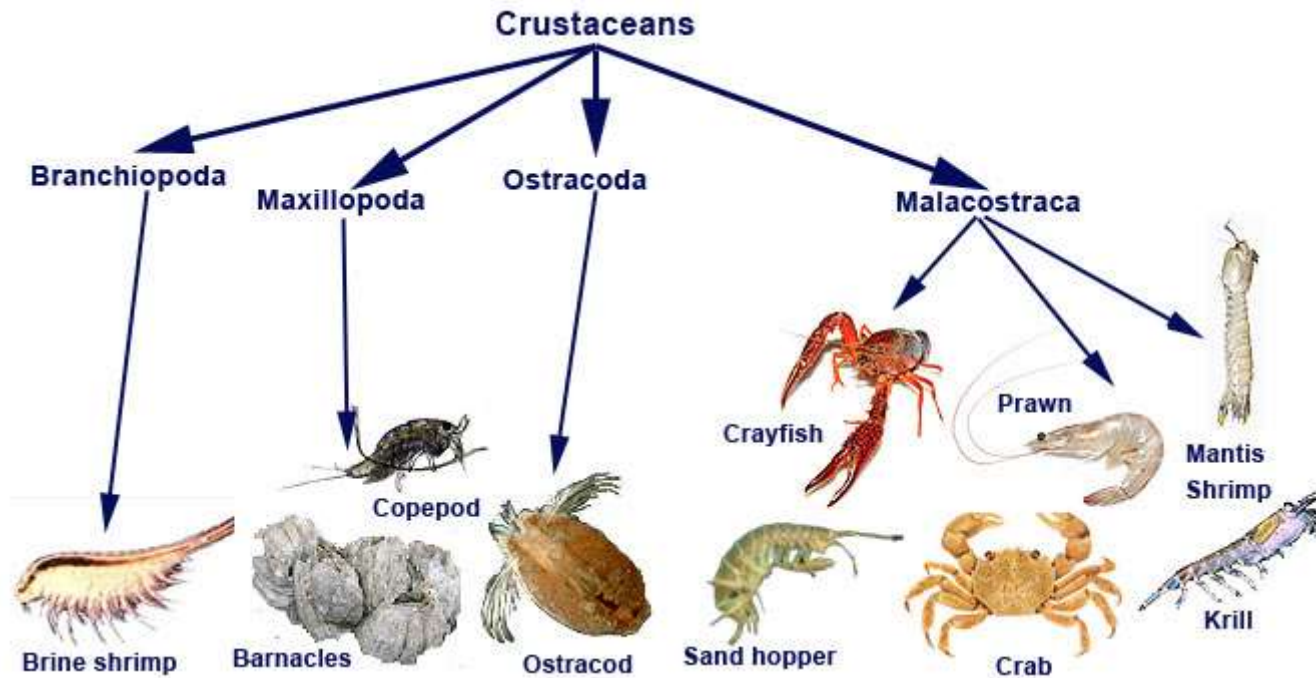


- Food





# CRUSTACEA EXSTREME DIVERSITY



Prof. Sanja Gottstein, Ph.D

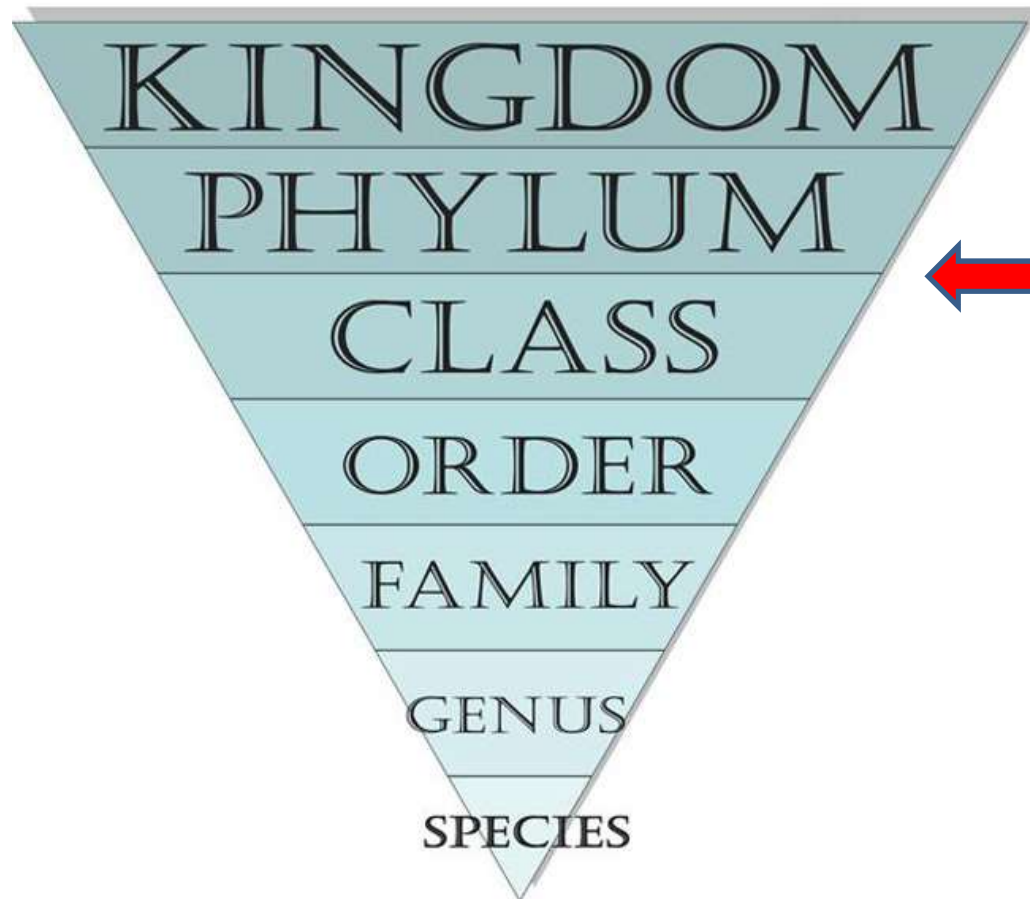
Department of Zoology– Faculty of Science, Zagreb

E-mail: [sanja.gottstein@zg.biol.pmf.hr](mailto:sanja.gottstein@zg.biol.pmf.hr)

# WHAT IS CRUSTACEA?

= the word comes from the Latin *crusta*, which means *shell*.

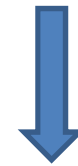
LEVEL OF CLASSIFICATION



MOST GENERAL



EACH LEVEL IS CALLED A TAXON

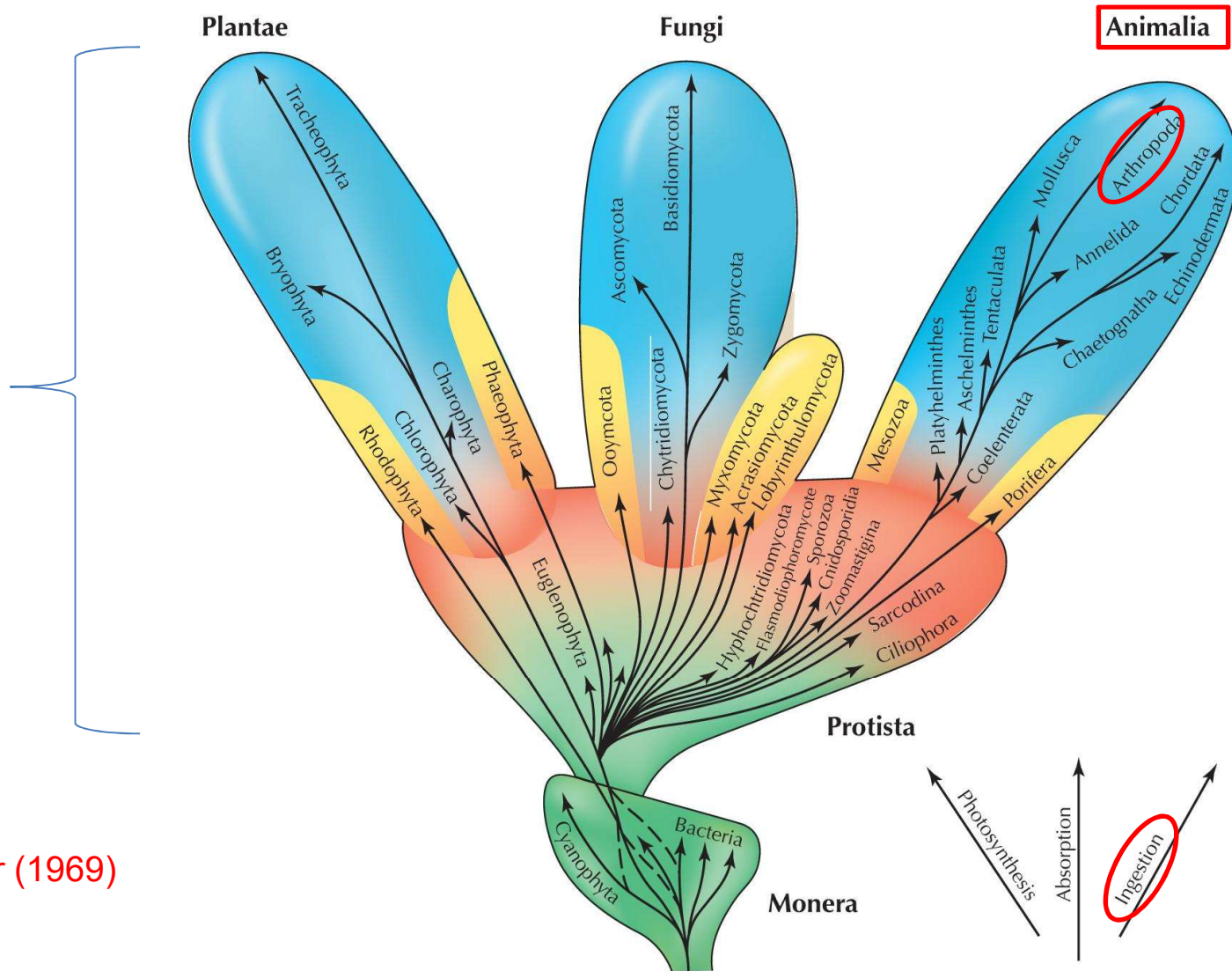


MOST SPECIFIC

# WHAT IS CRUSTACEA?

a classification system based on five kingdoms

Whittaker (1969)



# Classification of The Animal Kingdom (Metazoa)

---

## Non-Bilateria\*

(a.k.a. the diploblasts)

- PHYLUM PORIFERA
- PHYLUM PLACOZOA
- PHYLUM CNIDARIA
- PHYLUM CTENOPHORA

## Bilateria

(a.k.a. the triploblasts)

- PHYLUM XENACOELOMORPHA

### Protostomia

- PHYLUM CHAETOGNATHA

### SPIRALIA

- PHYLUM PLATYHELMINTHES
- PHYLUM GASTROTRICHA
- PHYLUM RHOMBOZOA
- PHYLUM ORTHONECTIDA
- PHYLUM NEMERTEA
- PHYLUM MOLLUSCA
- PHYLUM ANNELIDA
- PHYLUM ENTOPROCTA
- PHYLUM CYCLOPHORA

### Gnathifera

- PHYLUM GNATHOSTOMULIDA
- PHYLUM MICROGNATHOZOA
- PHYLUM ROTIFERA

### Lophophorata

- PHYLUM PHORONIDA
- PHYLUM BRYOZOA
- PHYLUM BRACHIOPODA

### ECDYSOZOA

#### Nematoida

- PHYLUM NEMATODA
- PHYLUM NEMATOMORPHA

#### Scalidophora

- PHYLUM KINORHYNCHA
- PHYLUM PRIAPULA
- PHYLUM LORICIFERA

#### Panarthropoda

- PHYLUM TARDIGRADA
- PHYLUM ONYCHOPHORA
- PHYLUM ARTHROPODA
- SUBPHYLUM CRUSTACEA\***
- SUBPHYLUM HEXAPODA
- SUBPHYLUM MYRIAPODA
- SUBPHYLUM CHELICERATA

#### Deuterostomia

- PHYLUM ECHINODERMATA
- PHYLUM HEMICHORDATA
- PHYLUM CHORDATA



---

\*Paraphyetic group



# CRUSTACEA ...

Kingdom Animalia

Vertebrates

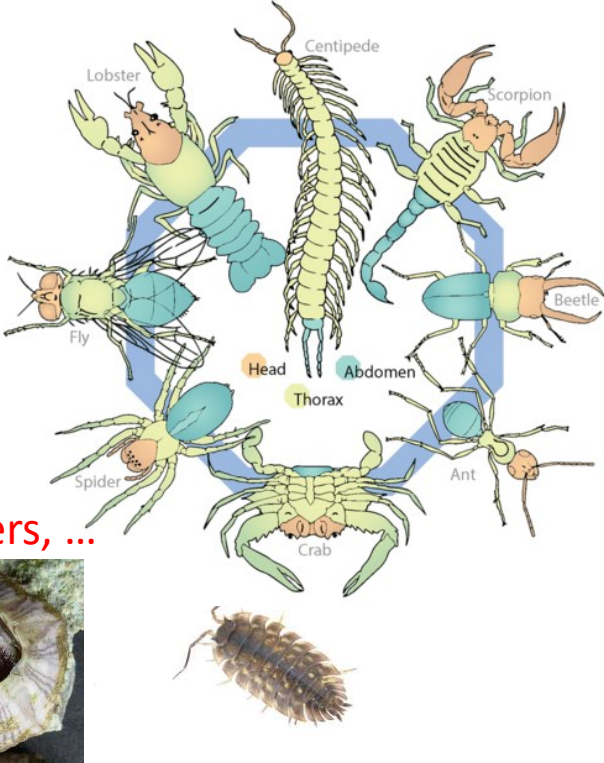


Invertebrates



heteronomous metamerism, chitinous exoskeleton, and joined appendages.

Phylum Arthropoda

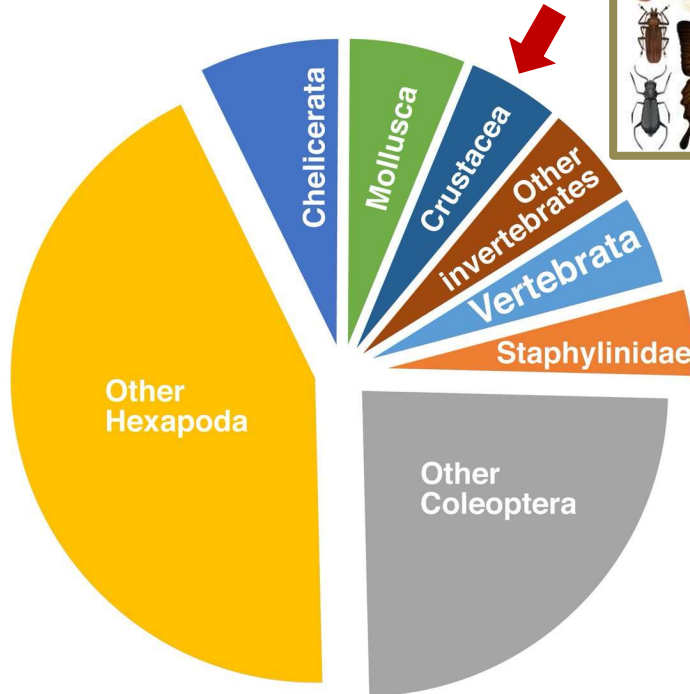
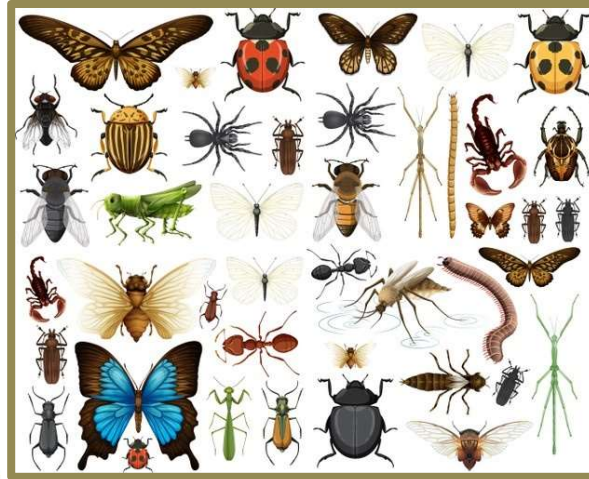


Subphylum Crustacea

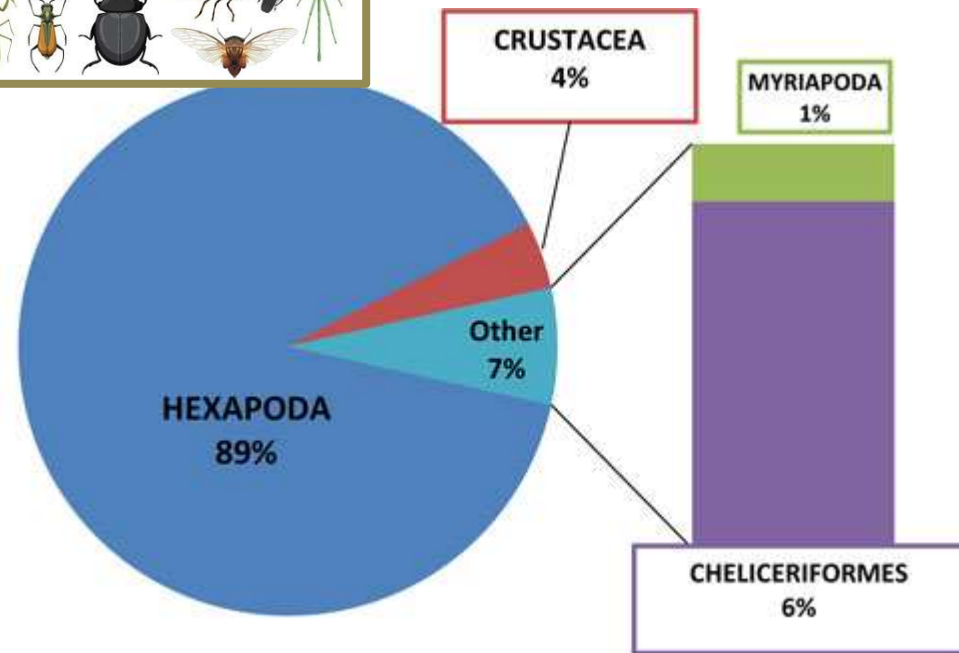
shrimps, crabs, lobsters, barnacles, slaters, ...



# RELATIVE DIVERSITY PHYLUM ARTHROPODA vs SUBPHYLUM CRUSTACEA



Parker, 2018



Holt & Iudica, 2015



*"No group of plants or animals on the planet exhibit the range of morphological diversity seen among the extant Crustacea."*

(Martin i Davis, 2001)

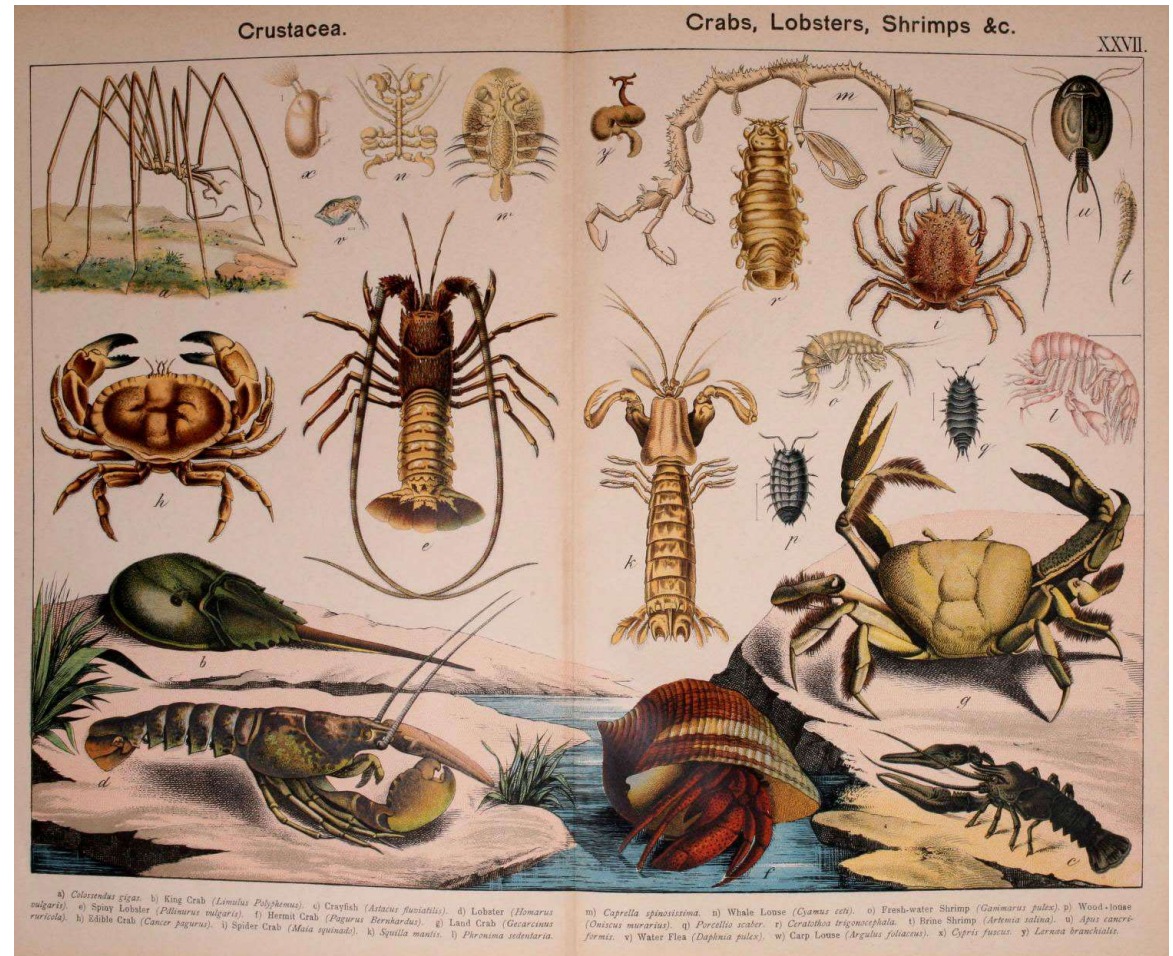


# 75.000 described representatives of the **subphylum Crustacea**

EXPECTATIONS:  $75.000 \times 5 - 10 = 335.000 - 750.000$  vrsta

“Treasures of the sea”

“Insects of the sea”



Kirby et al. 1889

# 1

## COMMENTS ON CRUSTACEAN BIODIVERSITY AND DISPARITY OF BODY PLANS

Frederick R. Schram

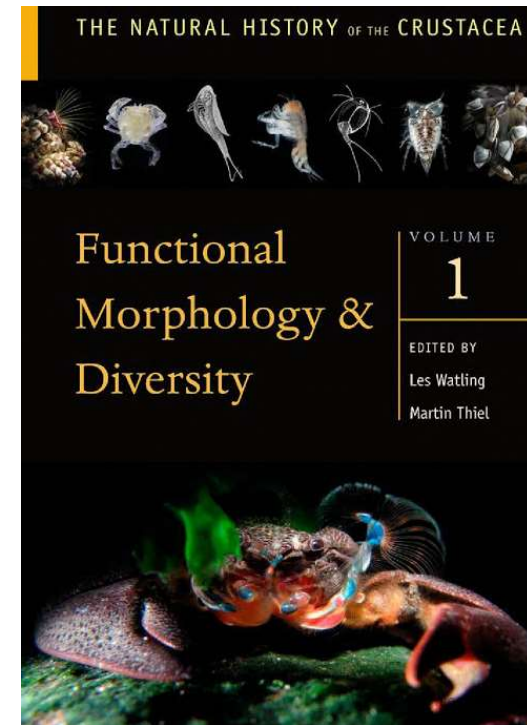
### Abstract

The science of natural history is built on twin pillars: cataloging the species found in nature, and reflecting on the variety and function of body plans into which these species fit. We often use two terms, *diversity* and *disparity*, in this connection, but these terms are frequently used interchangeably and thus repeatedly confused in contemporary discourse about issues of function and form. Nevertheless, diversity and disparity are distinct issues and must be treated as such; each influences our views of the evolution and morphology of crustaceans.

### CRUSTACEAN DIVERSITY

Crustaceans exhibit great disparity in basic body plans (I return to this subject below), but disparity of crustacean form is different from crustacean biodiversity, that is, the number of species we have within any particular group. No one knows for certain the exact number of species within any group of organisms, although the situation might improve with the appearance of online catalogs for particular groups. The people who set up these databases and maintain them as new species are added and old species are placed in synonymy provide a much-needed service toward adequately cataloging the tree of life. Nevertheless, as humans we like numbers—they are easily understood. So I have made my own tally (Table 1.1) and present a summary of estimates compiled from various authorities as to the total number of crustacean species.

There is clearly no agreement on numbers among the authors listed in Table 1.1, although the estimates have gone up through time. With the exception of Minelli (1993) and Brusca and



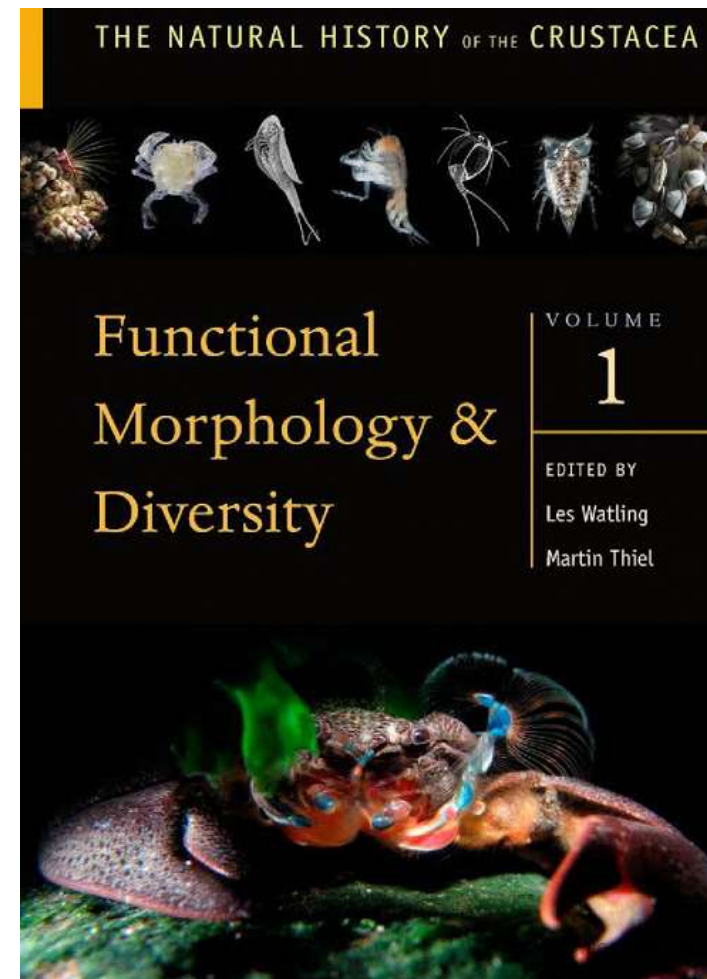
### Source

Bouchet (2006)  
Brusca and Brusca (1990)  
Brusca and Brusca (2003)  
Groombridge and Jenkins (2000)  
May (1988)  
Meglitsch and Schram (1991)  
Minelli (1993)  
Ruppert and Barnes (1994)  
This chapter



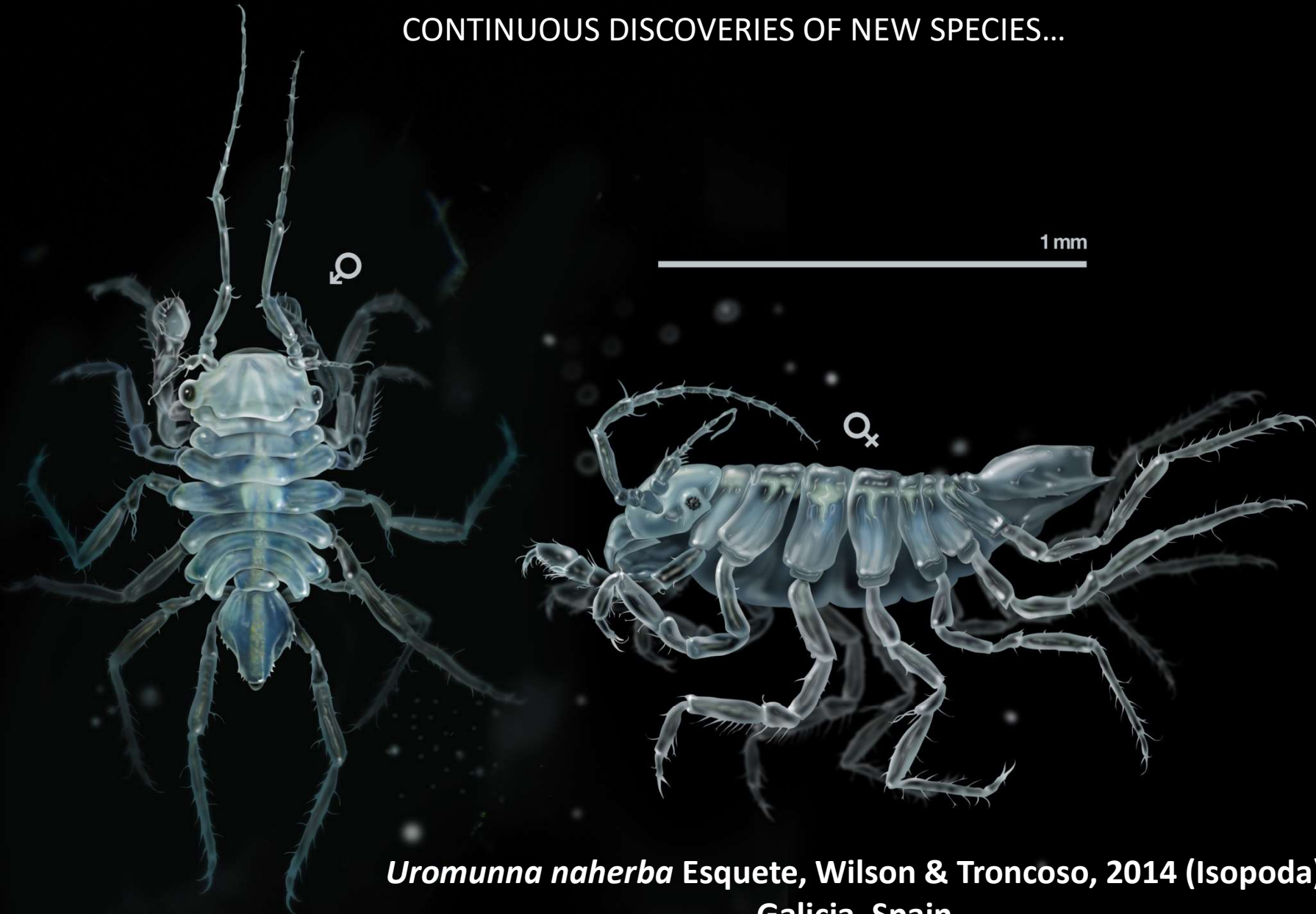
Taxon	Number of species
Branchiura (Argulida)	175
Branchiura (Pentastomida)	100
Mystacocarida	13
<b>Branchiopoda</b>	<b>509</b>
Anostraca	307
Cycletherida	1
Laevicaudata	36
Notostraca	15
Spinicaudata	≈150
Cladocera	450
<b>Maxillopoda</b>	<b>18,911</b>
Copepoda	9,500
Ostracoda	≈8,008
Myodocopida	1,608 (+500 fossils)
Podocopida	6,400 (+9,500 fossils)
Thecostraca	1,403
Ascothoracica	>99
Cirripedia	1,304
Acrothoracica	>61
Rhizocephala	>255
Thoracica	948
Facetotecta	12
Tantulocarida	28
<b>Remipedia</b>	<b>19</b>
<b>Cephalocarida</b>	<b>10</b>
<b>Malacostraca</b>	<b>29,471</b>
Phyllocarida	39
Stomatopoda	456
Eumalacostraca	28,976
Syncarida	>187
Bathynellacea	>170
Anaspidacea	17
Peracarida	15,686
Amphipoda	6,950
Cumacea	1,342
Isopoda	5,270
Lophogastrida	56
Mictacea	5
Mysida sensu lato	1,085
Mysida sensu stricto	1,075
Stygiomysida	10
Spelaeogriphacea	4
Tanaidacea	940

Taxon	Number of species
Thermosbaenacea	34
Eucarida	13,103
Amphionidacea	1
Decapoda	13,016
Dendrobranchiata	522
Caridea	2730
Stenopodidea	57
Reptantia	9,707
Euphausiacea	86
<b>Total</b>	<b>49,658</b>



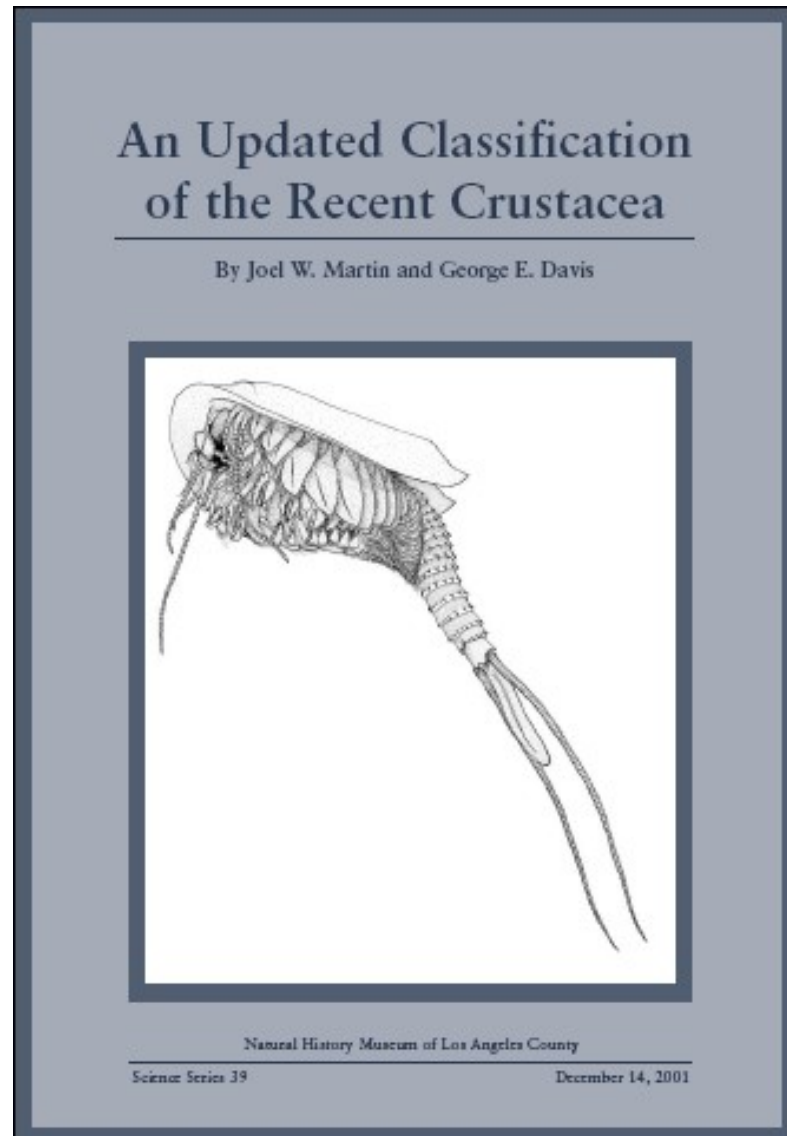


CONTINUOUS DISCOVERIES OF NEW SPECIES...



*Uromunna naherba* Esquete, Wilson & Troncoso, 2014 (Isopoda)  
Galicia, Spain

# CLASSIFICATION OF CRUSTACEA



- 5 CLASSES:

**Remipedia (12 sp.)**

**Cephalocarida (9 sp.)**

**Branchiopoda (10,000 sp.)**

**Malacostraca (20,000 sp.)**

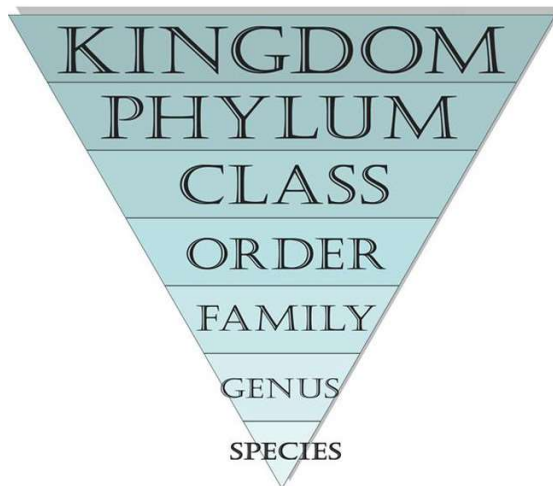
**Maxillipoda (10,000 sp.)**



(Martin & Davis 2001)

# CRUSTACEANS are...

## LEVEL OF CLASSIFICATION



- ✓ A **class** of **arthropods** which **breathes by gills** or similar structures, and have bodies which are covered by a **hard shell or crust**.
- ✓ A **group** of **mostly aquatic arthropods** ...
- ✓ A **large group** of **aquatic organisms** that fish eat.
- ✓ A **large subphylum** Crustacea often with a **hard shell**.
- ✓ **Large class** of **animals**, mostly **aquatic**, with **hard shells**.
- ✓ Includes many **microscopic organisms**...
- ✓ A **group** of **hard-shelled invertebrates** ...
- ✓ A **large class** of **animals**, usually living in or near the **water**, that have a **hard crustlike outer covering** (exoskeleton).
- ✓ **Water animals** with an **outside skeleton or shell**.
- ✓ A **group** of predominately **aquatic animals** including crabs, shrimps, and barnacles, having **hard outer skeletons or shells, and paired, jointed, limbs**.
- ✓ **Organisms**, generally **aquatic**, characteristically having a **segmented body, a hard external covering, and paired jointed limbs**
- ✓ **Aquatic invertebrates**, that have **segmented bodies, jointed legs, and exoskeletons**
- ✓ **Invertebrates** characterized by a **hard outer shell and jointed appendages and bodies**.
- ✓ ...

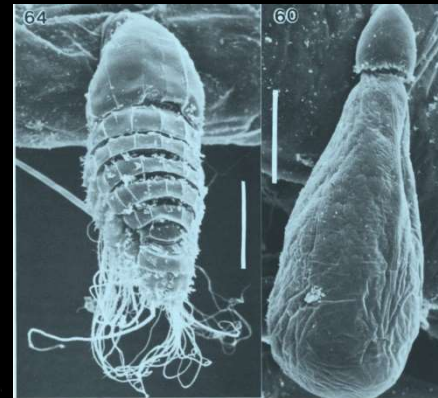


# We can be both very big and very small!

Morphology



Size



100  $\mu\text{m}$

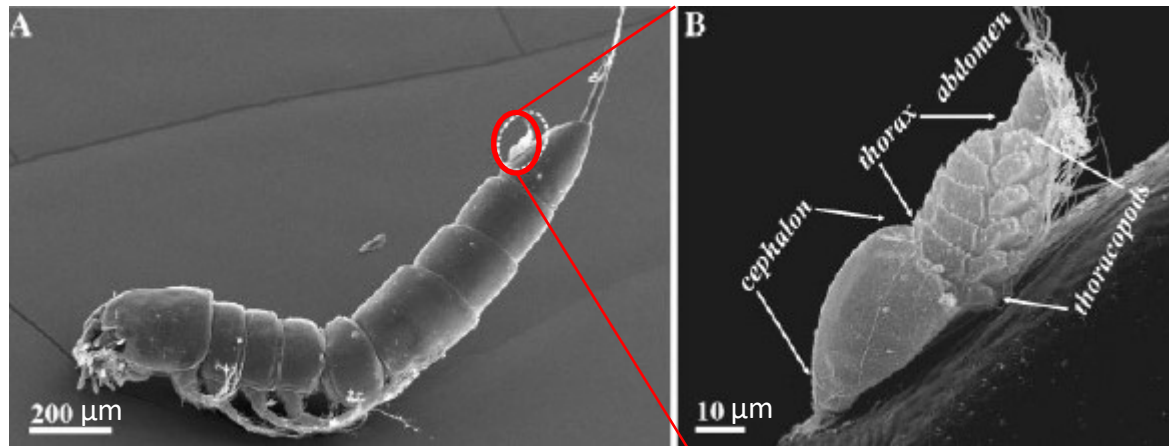
Tantulocarida



4 m

*Pseudocarcinus gigas*

# WHICH IS THE SMALLEST CRUSTACEANS IN THE WORLD?



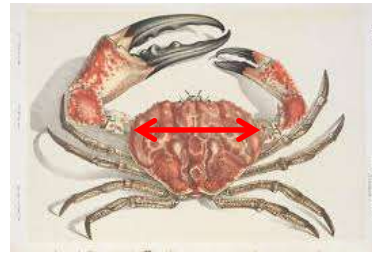
Harpacticoida

Tantulocarida

Ectoparasite crustacean species *Serratotantulus chertoprudae* on the copepod crustacean Harpacticoida

Savchenko i Kolbasov 2009. *Serratotantulus chertoprudae* gen. et sp. n. (Crustacea, Tantulocarida, Basipodellidae): A new tantulocaridan from the abyssal depths of the Indian Ocean. *Integrative and Comparative Biology*, 49, 2: 106–113.

# WHICH IS THE LARGEST CRUSTACEAN IN THE WORLD?



46 cm

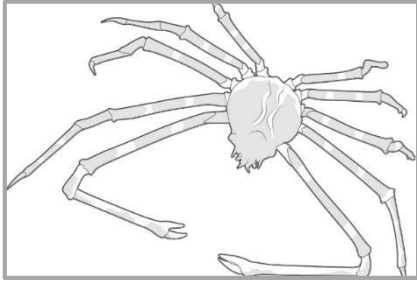


*Pseudocarcinus gigas* (Lamarck, 1818) – Tasmanian giant crab

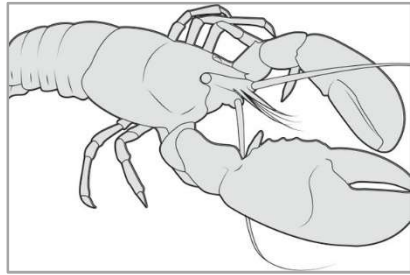


# GIANTS

1. *Macrocheira kaempferi* – diameter of legs 4 m



2. *Homarus americanus* – body length 1 m



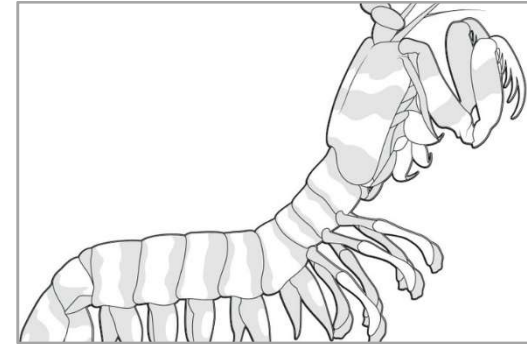
3. *Birgus latro* – diameter of legs 1 m



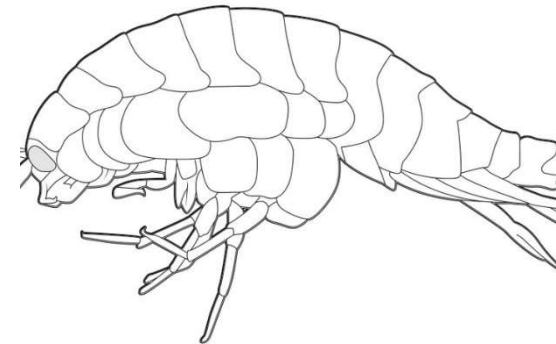
4. *Pseudocarcinus gigas* – diameter of legs 80 cm



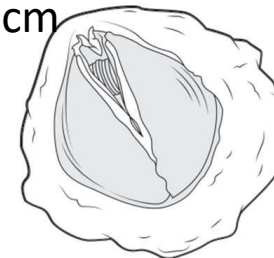
5. *Lysiosquilla maculata* – length 40 cm



6. *Alicella gigantea* – length 34 cm



7. *Balanus nubilus* – diameter of body 30 cm



# DEEP SEA GIGANTISM

ISOPODA

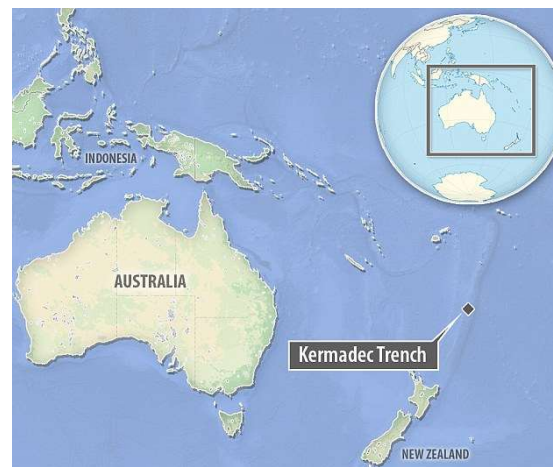


*Bathynomus giganteus*

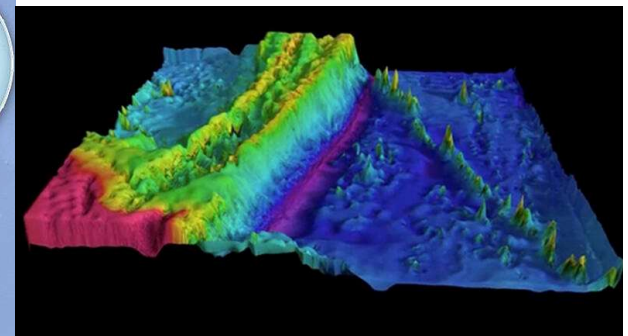
AMPHIPODA



*Alicella gigantea*



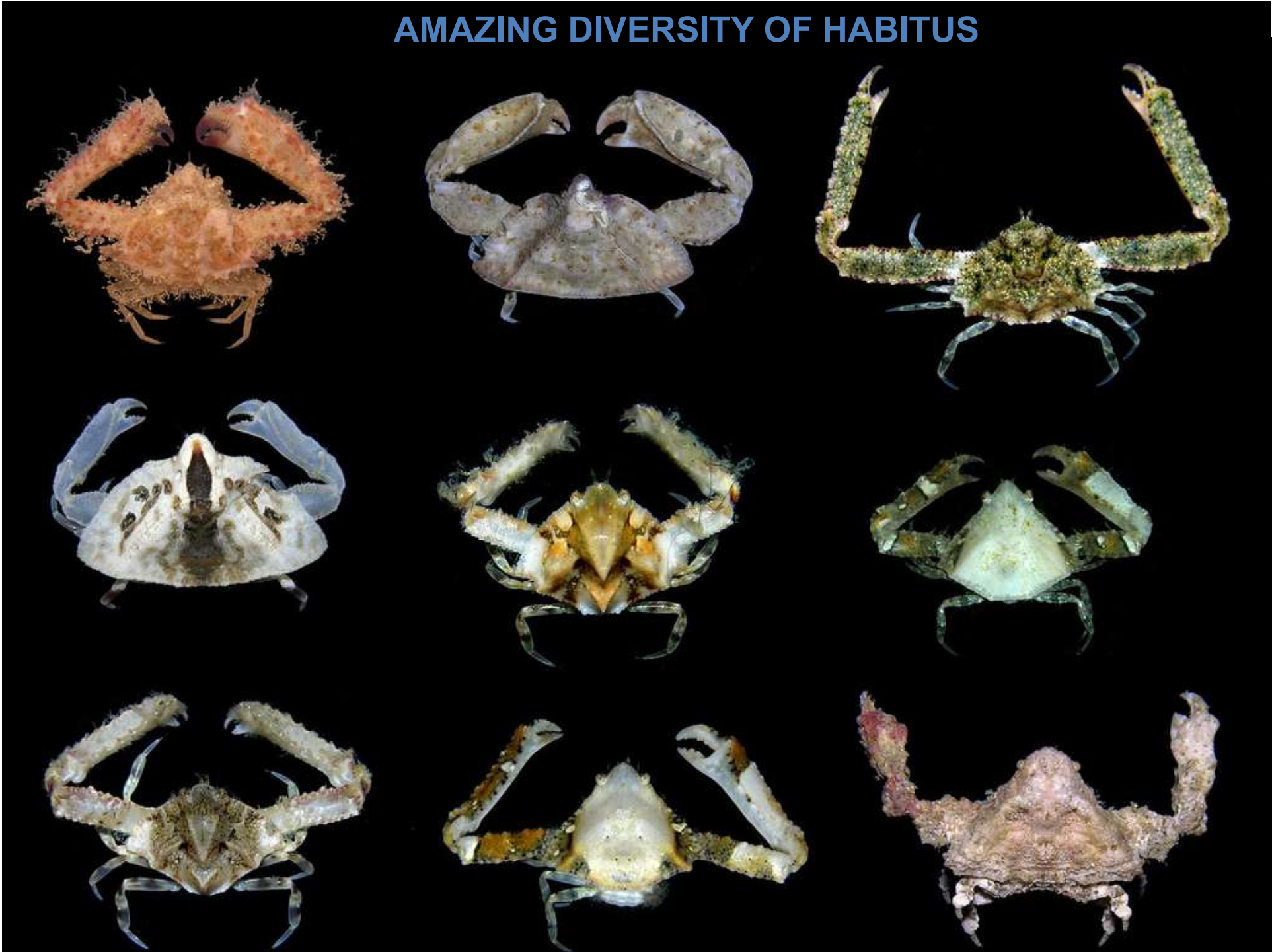
**Kermadec Trench**



**4194m-5281m depth**



AMAZING DIVERSITY OF HABITUS





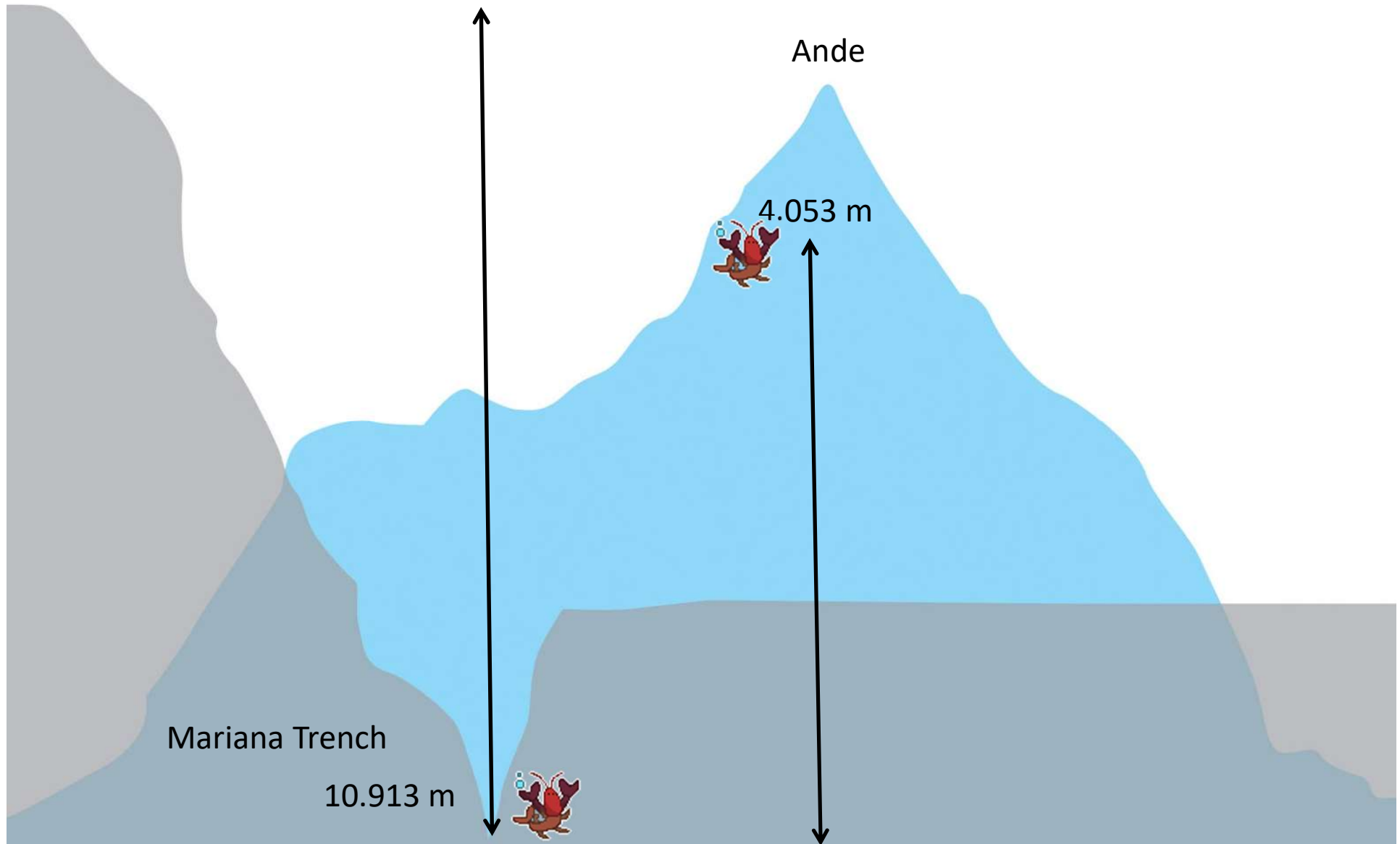
# AMAZING BEAUTY



# AMPHIPODA – ALIENS AMONG CRUSTACEANS

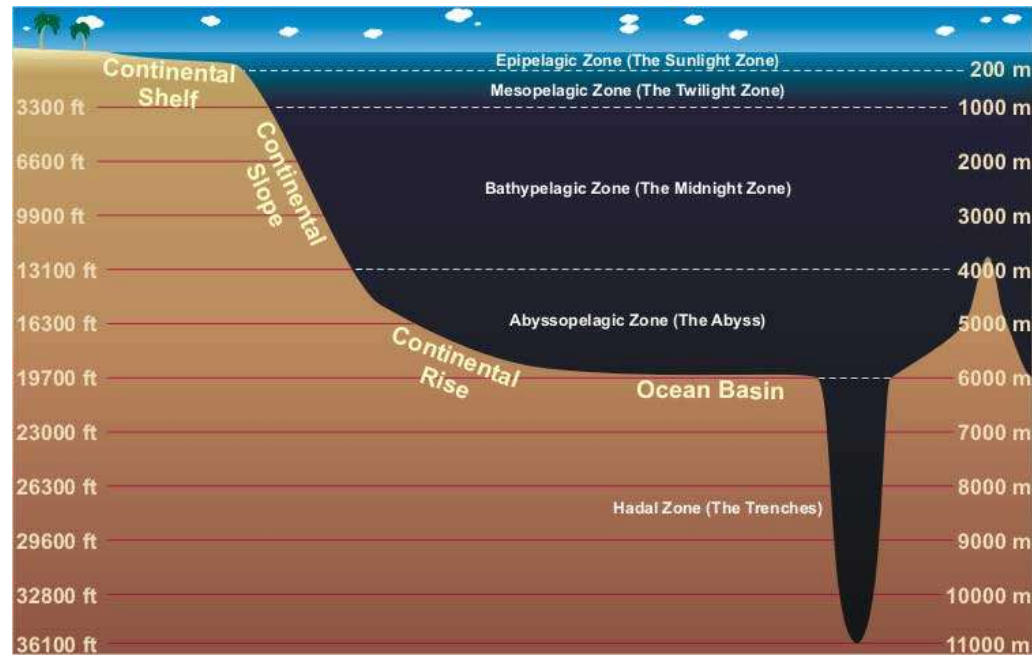


# THEY ARE DISTRIBUTED EVERYWHERE





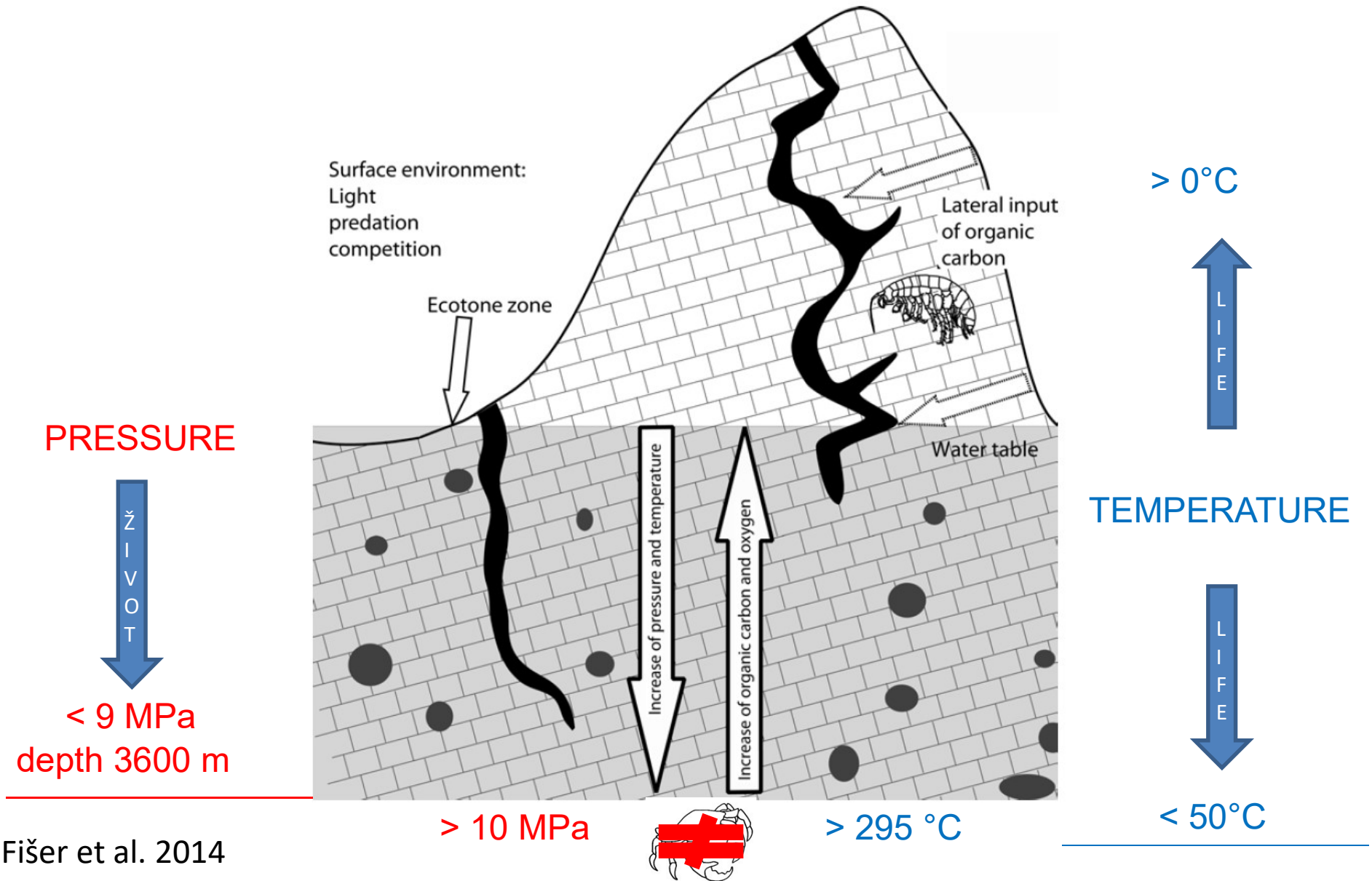
# FROM THE BOTTOM OF THE DEEP OCEANS



*Leptochelia longimana*

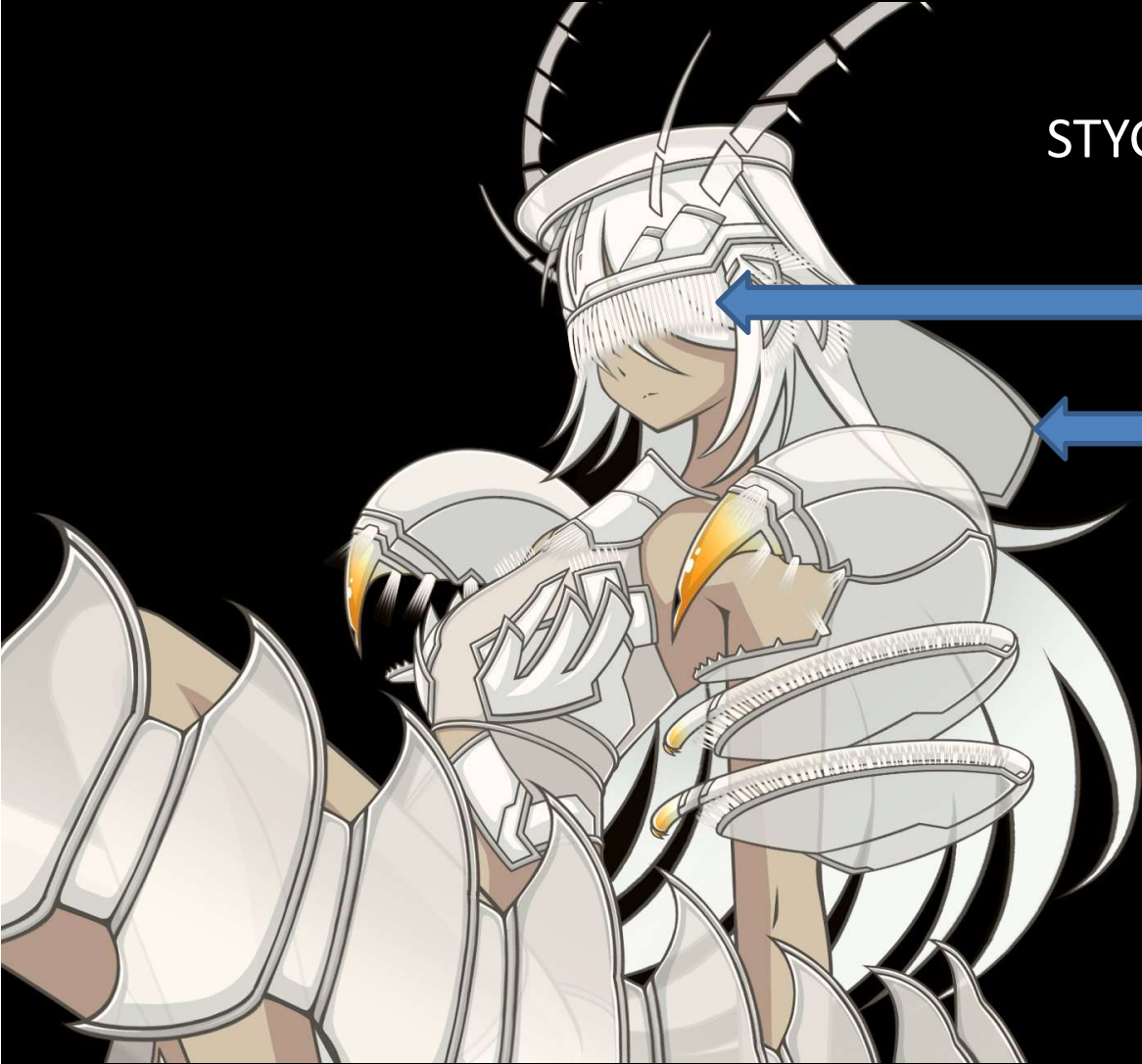


# TO WHICH EXTREMES OF UNDERGROUND HABITATS?





# STYGOBITIC CRUSTACEANS



EYELESS

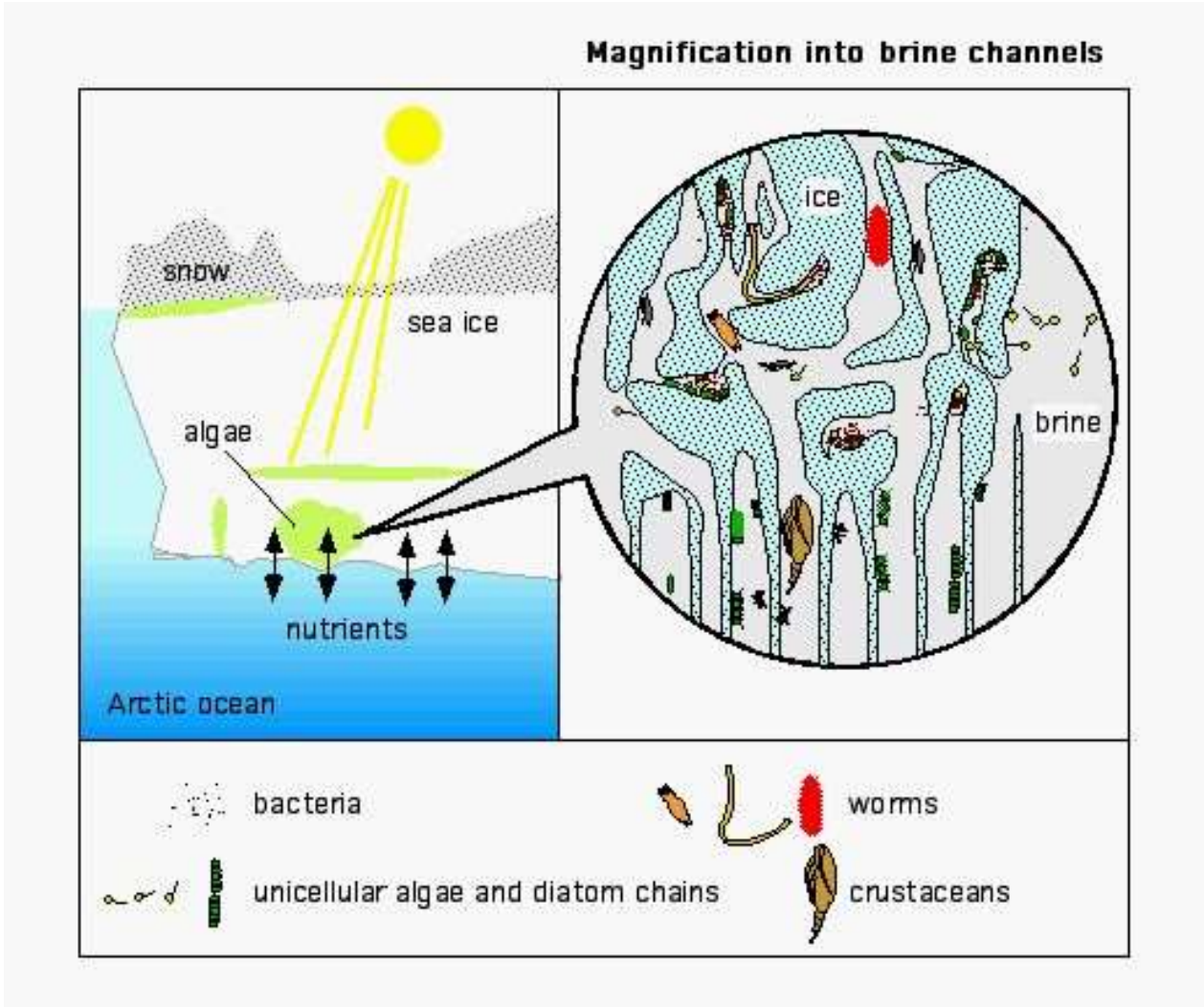


DEPIGMENTED



can live frozen in ice for several hours

# EVEN IN ICE SANTs!!!



# CRUSTACEAN BIOMASS IN THE OCEANS !?

- most widespread
- the most diverse
- the most numerous

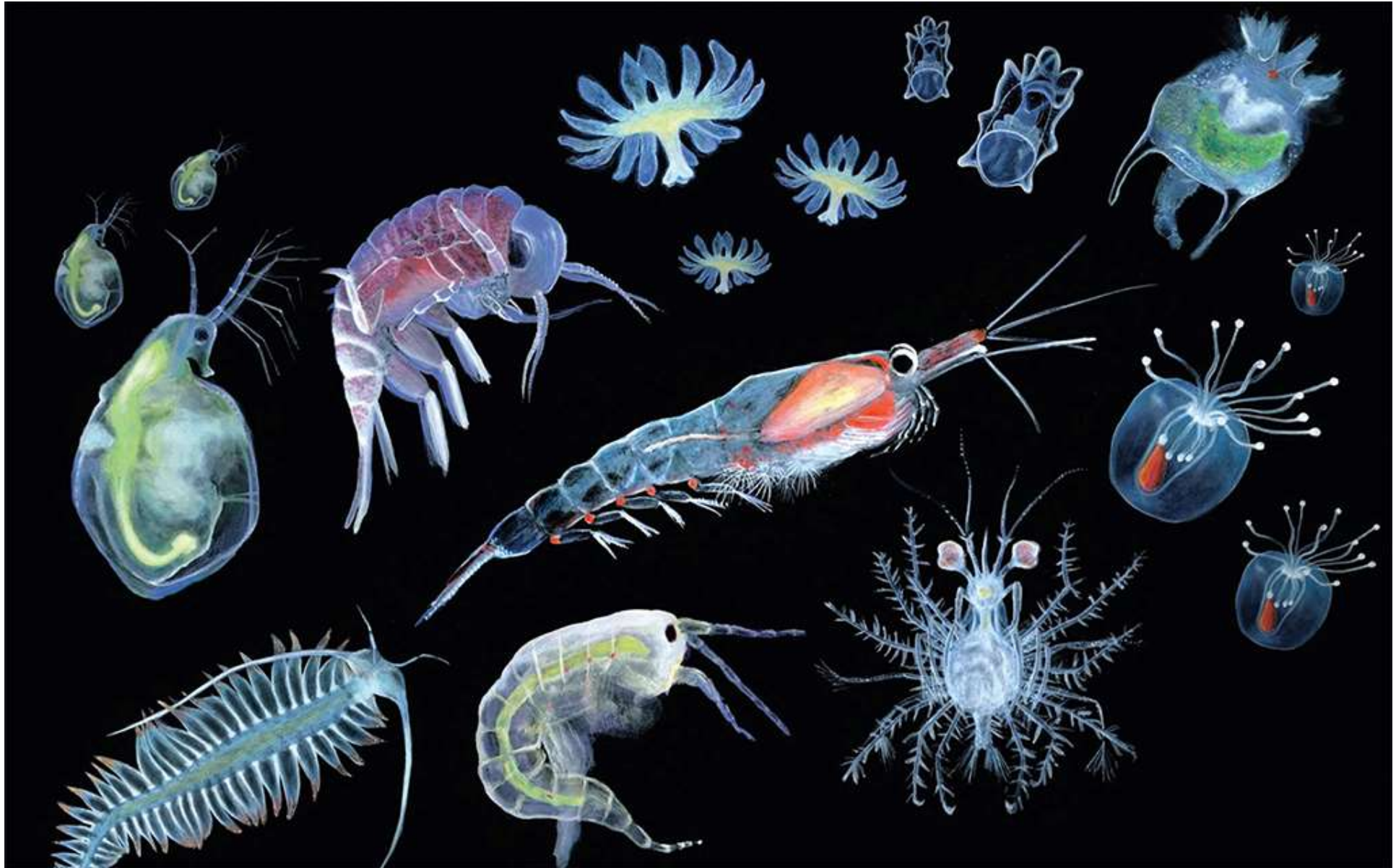


The biomass of only one species of Antarctic krill - *Euphausia superba*, is estimated at 500 million tons, which is far more than any representative of Metazoa, thus competing with all the ants in the world.





# HOLOPLANKTON



# MEROPLANKTON





They conquered the mainland!!!





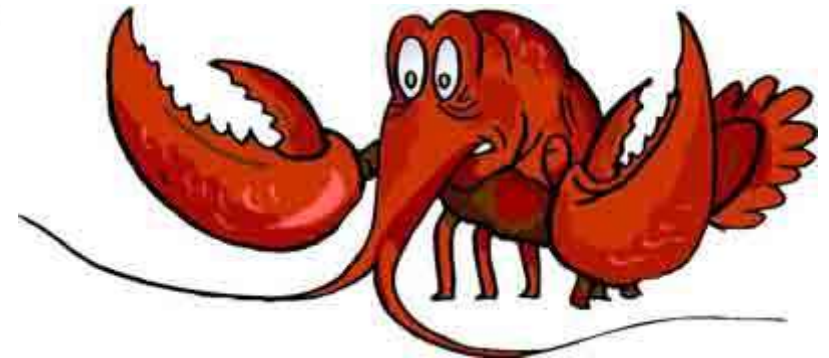
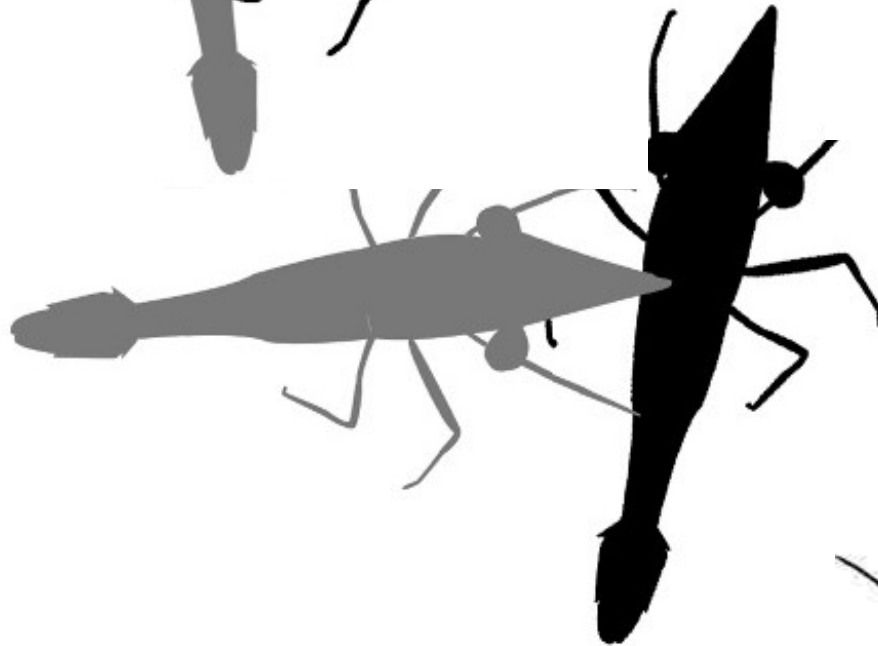
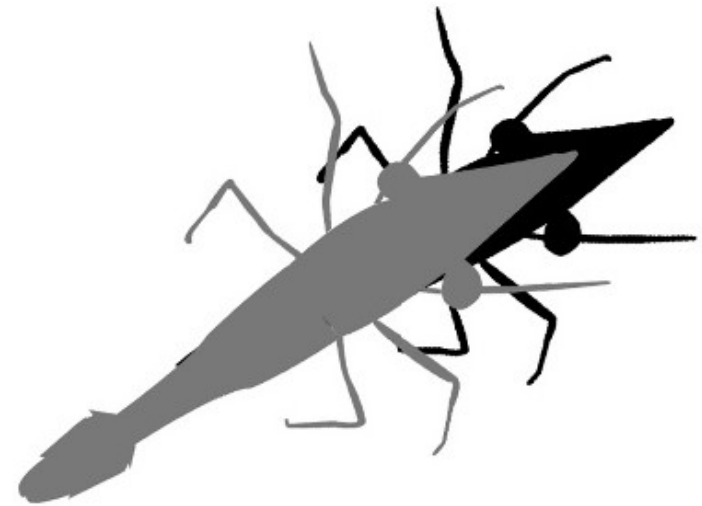
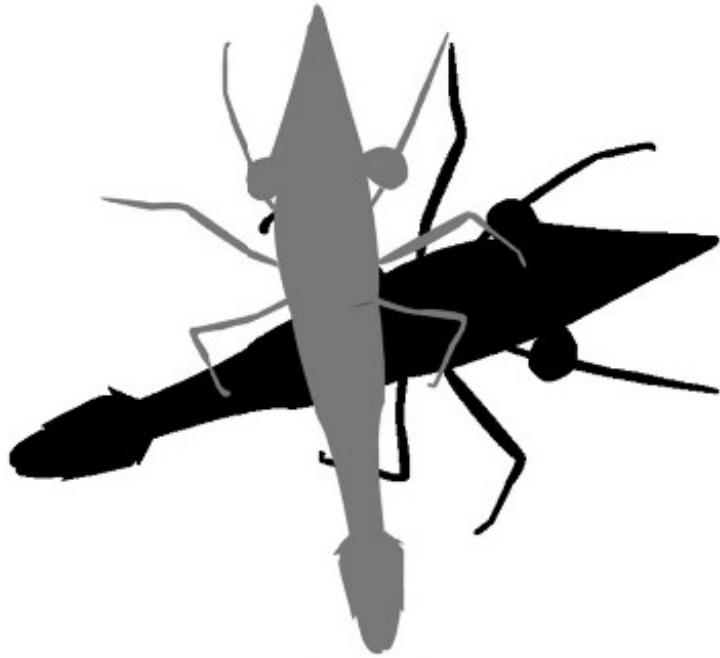
## WHO ARE THE MOST SUCCESSFUL LAND CONQUERORS?



commonly known as pill bugs (*Isopoda terrestria*)

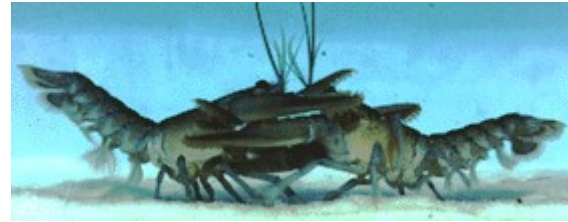
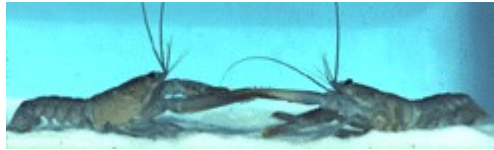


social life, courtship,...?



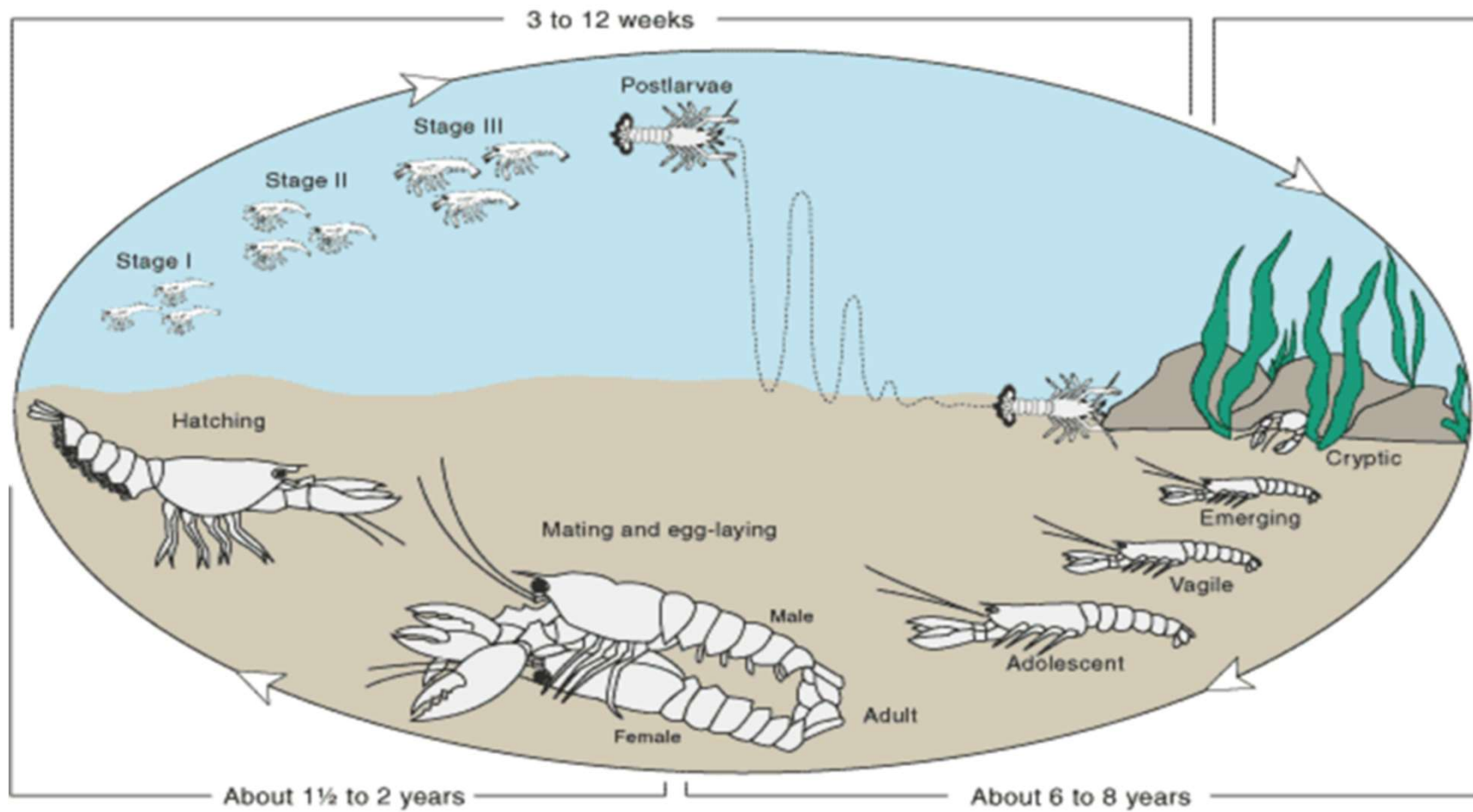


# PEACEMAKERS vs WARRIORS

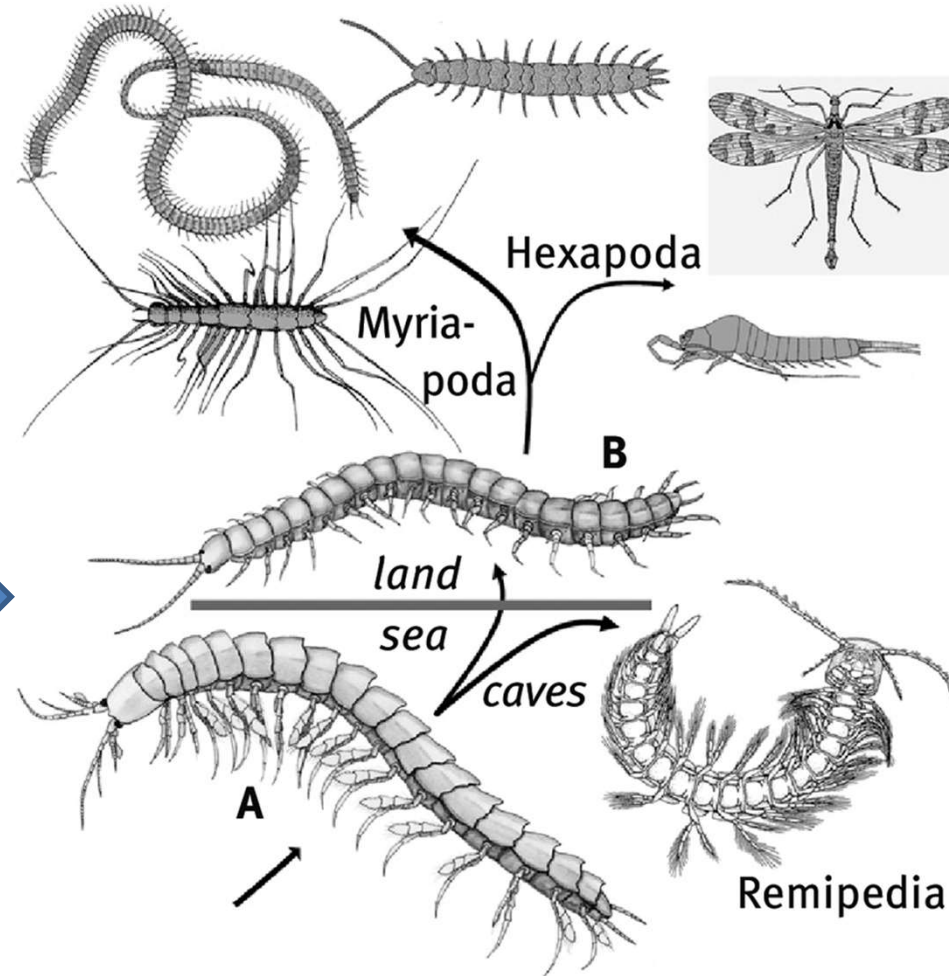


“I will cut you man!!!”

# LIFE HISTORY vs LIFE CYCLE



# HEXAPODA vs. CRUSTACEA



## ORDER REMIPEDIA



# ATTRACTIVE, FAST, STRONG, SHARP EYE,...

- ❖ Mantis shrimp hold the title for the fastest punch in the animal kingdom—powerful enough to break seashells and aquarium glass.
- ❖ They also boast some of the world's most complex, extraordinary eyes. Human eyes have three kinds of light receptor cells, but these shrimp have a dozen, allowing them to sense properties of light invisible to other animals.



**STOMATOPODA**

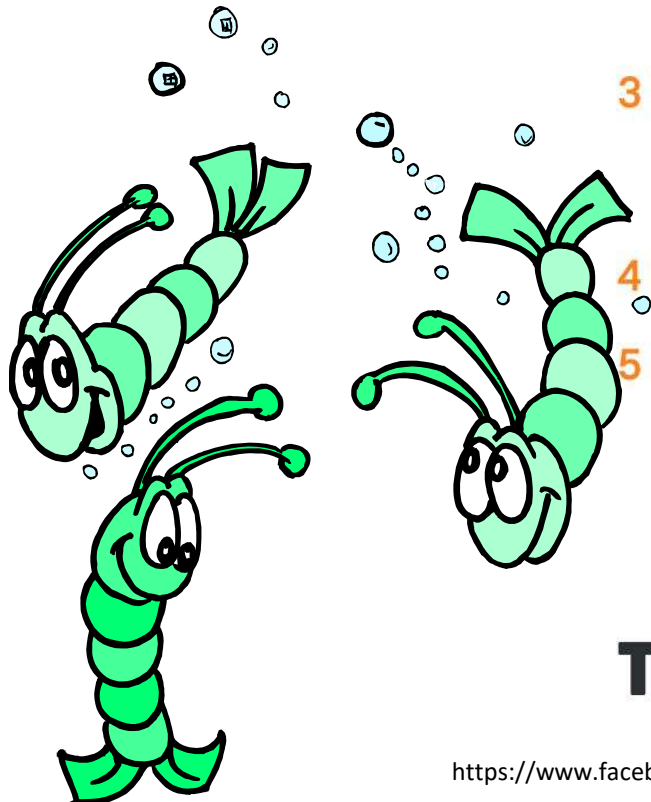
# 5 REASONS WHY CRUSTACEANS ARE COOL



- 1 Some crabs, disguise themselves by attaching living things, such as anemones, to their bodies
- 2 The pistol shrimp can deliver an explosive attack at predators hotter than the surface of the sun, and loud enough to rupture a human ear drum!
- 3 The Pea Crab is the smallest known species. It measures between 0.27 and 0.47 inches long...about the same as a pea!
- 4 A shrimp's heart is located in its head!
- 5 In order to grow larger, crayfish must shed their shell. They usually eat the old shell in order to recover the calcium and phosphates contained in it



**TRY VEGAN THIS MONTH**





QUESTIONS???

CRUSTACEAN  
SOLDIERS  
UNDRESSED VERSION



HERMIT  
CRAB



SWIMMING  
CRAB

TIGER  
PRAWN





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